Evolution 500
User Manual

Note

This manual is being revised, so some of the information you will find in it is out-of-date. Please accept our apologies for any confusion this may cause. Any reference to Unicam, Spectronic Instruments or Thermo Spectronic has changed to Thermo Electron Corporation, and the contact and trademark information has also changed. On the next page, you will find a current disclaimer and up-to-date contact and trademark information. Please contact Thermo Electron if you have any questions or concerns.

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CE
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Marking with the symbol CE indicates compliance of this Thermo Electron system to the following European Directives:

89/336/EEC	Electromagnetic Compatibility directive (EMC)
73/ 23/EEC	Electrical equipment designed for use within certain voltage limits (Low voltage directive)

Such marking indicates that this Thermo Electron system meets or exceeds the technical standards listed in the Declaration of Conformance.

DECLARATION OF CONFORMITY
according to ISO/IEC Guide 22 and EN 45 014

Manufacturer's Name:	Thermo Electron
Manufacturer's Address:	Mercers Row Cambridge, CB5 8HY UK

declares, that the product(s):

Product name:	UV-Visible Spectrophotometers
Model Number(s):	Nicolet Evolution 500

conforms to the following Product Specifications:

Safety:	BS EN 61010-1 : 1993	Part 1 General Requirements
EMC:	EN 50 082-1	Light Industrial Generic Immunity Standard
	IEC 801-2	Electrostatic Discharge 8k V, 15 kV
	IEC 801-3	RF Field Immunity 3 V/m, 10 V/m
	IEC 801-4	Electrical Fast Transients
	EN 50-081-1	Light Industrial Generic Emission Standard
	EN 55 022 Class B	ITE Radio Frequency Emission
	FCC 47CFR Part 15 /B Class A	

Supplementary Information:
The documentation relating to this declaration is on file. The products herewith comply with the requirements of the Low Voltage Directive 73/23/ECC and the EMC Directive 89/336/ECC.

1 August 2003	G Smart
Cambridge	Manufacturing Director

Notices:

1. About the system: Use only with Thermo Electron approved computer and accessories
2. About Shielded Cables: Use only shielded cables supplied by Thermo Electron when connecting this instrument to computer and accessories.

Compliance with the above notices is necessary to ensure that the appropriate radio frequency emissions will be maintained within the limits of the specifications referred to in this declaration.

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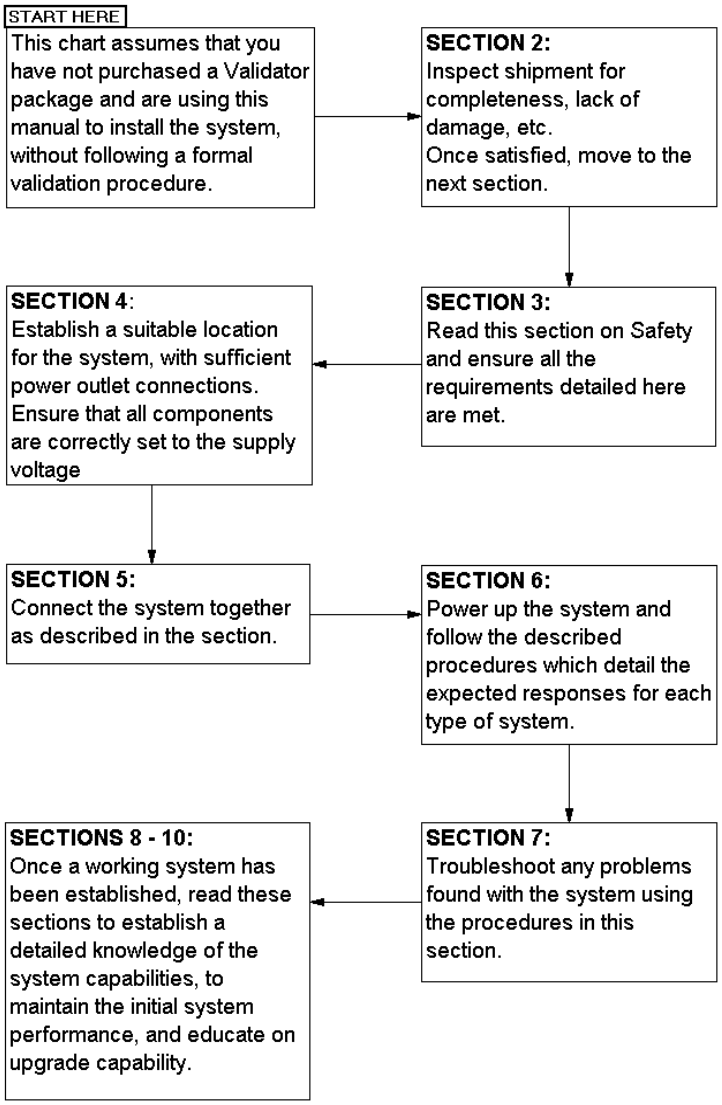
SECTION 1 - OVERVIEW

1.1 Introduction

1.1.1 Installation and Maintenance

This User Manual has been designed to assist you with the installation of a Nicolet Evolution 500 UV-Visible Spectrophotometer system. Detailed below is how we anticipate this process will occur.


START HERE
This chart assumes that you have not purchased a Validator package and are using this manual to install the system, without following a formal validation procedure.
SECTION 2:
Inspect shipment for completeness, lack of damage, etc.
Once satisfied, move to the next section.
SECTION 3:
Read this section on Safety and ensure all the requirements detailed here are met.
SECTION 4:
Establish a suitable location for the system, with sufficient power outlet connections.
Ensure that all components are correctly set to the supply voltage
SECTION 5:
Connect the system together as described in the section.
SECTION 6:
Power up the system and follow the described procedures which detail the expected responses for each type of system.
SECTION 7:
Troubleshoot any problems found with the system using the procedures in this section.
SECTIONS 8 - 10:
Once a working system has been established, read these sections to establish a detailed knowledge of the system capabilities, to maintain the initial system performance, and educate on upgrade capability.

1.2 Sections which must be read and followed in sequence for correct installation

1.2.1 SECTION 1 - Overview

A brief summary of the structure of the manual, together with a flow chart of the installation process

1.2.2 SECTION 2 - Unpacking and Initial Inspection of the System

This section deals with the initial unpacking and inspection of all potential components of the basic system, i.e. spectrophotometer, computer, printer and plotter. Installation of any supplied accessories is covered by their own respective manual.

1.2.3 SECTION 3 - Safety considerations

This section details the basic safety issues that must be considered when installing a Nicolet Evolution 500 spectrophotometer system.

1.2.4 SECTION 4 - Location and Power requirements

This section deals with the correct location of all potential components of the basic system, i.e. spectrophotometer, computer, printer and plotter. Installation of any supplied accessories is covered by its own respective manual.

1.2.5 SECTION 5 - System interconnections

This section covers the complete Nicolet Evolution 500 system interconnections.

1.2.6 SECTION 6 - System Power Up

This section details the application of power to a correctly configured system, and the system responses the user should expect if everything is OK.

1.2.7 SECTION 7 - Troubleshooting

This section is intended to guide the user towards taking the appropriate action required to reduce the instrument downtime to a minimum. It deals only with those items of service which can be safely carried out by the operator.

1.3 Reference sections - once installation has been achieved

1.3.1 SECTION 8 - System Description

This section gives basic system descriptions, part numbers, etc.

1.3.2 SECTION 9 - Getting the best from your Nicolet Evolution 500 Instrument

The Nicolet Evolution 500 double beam, scanning UV-Visible spectrophotometer offers one of the best value for money systems on the market. It is the purpose of this section to help you get the best from your Nicolet Evolution 500 spectrophotometer.

1.3.3 SECTION 10 - Maintenance

The information given in this section deals only with those parts of maintenance or service which can be safely carried out by the user. Work other than that detailed should be carried out by a service engineer.

SECTION 2 - UNPACKING AND INITIAL INSPECTION

This section deals with the initial unpacking and inspection of all potential components of the basic system, i.e. spectrophotometer, computer, printer and plotter. Installation of any supplied accessories is covered by its own respective manual.
Once the components are unpacked and checked OK, move on to Section 3 for Safety Instructions.

2.1 Unpacking the Spectrophotometer

(1) Check the contents of the shipment against the delivery note received with the equipment (in the spectrophotometer box) for completeness and possible transport damage.

Note: If the contents are incomplete, or damaged, a claim should immediately be filed with the carrier. The local Sales organisation (or nearest Agent) should be notified by telephone (confirmed in writing) of any damaged or missing items, in order to facilitate replacement or repair.

(2) Open the box containing the spectrophotometer and read the enclosed yellow card. **If you have purchased the Validator package, stop at this point and continue the Installation using the Validator Log supplied.**

(3) Remove to a safe location the following:

- The User manual and, if the spectrophotometer is a Standalone Evolution 500, the Local Control Software Operating Manual.
- Certificates of Commissioning and Compliance to Specification.
- Pack of spare fuses, etc.

(4) Remove the top of the carton and pick up the instrument via the recesses in the bottom of the carton.

Caution: The instrument weighs 29 Kg.

(5) Locate in a suitable position (see Section 4).

2.2 Unpacking the Computer (if appropriate)

Due to the rapid rate of technological improvement, Thermo Electron update their list of approved computers and disk operating systems from time to time. Please contact your local Thermo Electron Sales Office (or agents) for further information on currently approved computers.

Each computer comprises the following major items:

Base Unit

Keyboard

Monitor

Mouse

Check the contents of the shipment against the delivery note received with the equipment for completeness and possible transport damage.

If the contents are incomplete or damaged, a claim should immediately be filed with the carrier. The nearest Thermo Electron Sales Organisation (or Agents) should also be notified by telephone (confirmed in writing) of any damage and/or items not supplied in order to facilitate repair or replacement.

2.3 Unpacking the Printer/Plotter (if appropriate)

Due to the rapid rate of technological improvement, Thermo Electron update their list of approved printers/plotters from time to time. **This is particularly appropriate for details of serial printers/plotters directly supported by a Standalone Evolution 500 spectrophotometer.** Please contact your local Thermo Electron Sales Office (or agents) for further information on currently approved printers.

Check the contents of the shipment against the delivery note received with the equipment for completeness and possible transport damage.

Unpack the printer/plotter according to the manufacturer's instructions found in the printer/plotter box.

If the contents are incomplete or damaged, a claim should immediately be filed with the carrier. The nearest Thermo Electron Sales Organisation (or Agents) should also be notified by telephone (confirmed in writing) of any damage and/or items not supplied, in order to facilitate repair or replacement.

SECTION 3 - SAFETY CONSIDERATIONS

This section details the basic safety issues that must be considered when installing a Nicolet Evolution 500 spectrophotometer system. Once this section has been read move on to Section 4, and locate the components ready for interconnection.
Read this page carefully before installing and using the instrument and its accessories. The safety statements in this manual comply with the requirements of the HEALTH AND SAFETY AT WORK ACT 1974.
The instrument and accessories described in this manual are designed to be used by properly trained personnel only. Adjustment, maintenance and repair of exposed equipment must be carried out only by qualified personnel who are aware of the hazards involved. Where indicated in the relevant manual, certain maintenance processes may be carried out by the user, who must be fully aware of, and apply, the following safety precautions.

3.1 Safety Precautions

For the correct and safe use of this instrument and its accessories it is essential that both operating and servicing personnel follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

Specific warning and caution statements, where applicable, can be found throughout this manual. Warning and caution statements and/or symbols are marked on the apparatus where necessary.

The instrument covers and accessories should be removed only by personnel who have been trained to avoid the risk of electric shocks. The mains electricity supply to the instrument must be disconnected at the mains supply connector and at least three minutes allowed for capacitors to discharge.

Some of the chemicals used in spectrophotometry are corrosive, and/or flammable and samples may be radioactive, toxic or potentially infectious. Care should be taken to follow the normal laboratory procedures for handling chemicals.

The UV radiation from a Deuterium lamp can be harmful to the skin and eyes. Always view the lamp through protective glasses/goggles that will absorb the UV radiation and avoid looking directly at the Deuterium arc. Do not expose the skin to direct or reflected UV radiation.

3.2 Cautions and Warning Statements

Caution: **Used to indicate correct operating or maintenance procedures in order to prevent damage to, or destruction of, equipment or other property.**

WARNING: **Indicates a potential danger that requires correct procedures or practices in order to prevent injury to personnel.**

3.3 Impaired Safety Protection

Whenever it is likely that safety protection has been impaired, the instrument and/or accessory must be made inoperative and secured against any unintended operation. The matter should then be referred to the appropriate servicing authority. Safety protection is likely to be impaired if, for example, the instrument fails to perform the intended measurements or shows visible damage.

3.4 Explanation of Symbols

	(yellow/black) (red/white)	To protect the instrument from damage, the operator must refer to an explanation in the Users Manual.
	(white/black)	Protective earth (ground) terminal.

SECTION 4 - LOCATION AND POWER REQUIREMENTS

This section deals with the correct location of all potential components of the basic system, i.e. spectrophotometer, computer, printer and plotter. Installation of any supplied accessories is covered by its own respective manual.
Once the components are suitably located, move on to Section 5 for detailed interconnection instructions.

4.1 Locating the spectrophotometer

The system is designed for use on a normal desk or bench, wide enough to ensure that all four feet sit on the surface. The mounting surface must be level and the spectrophotometer must not be placed on any type of cushioning, as this could block ventilation.

When siting the system consider the environment in which the equipment is to be used. Some of the factors that may adversely affect the operation of the spectrophotometer and associated equipment are given below.

4.1.1 Static electricity

Static electricity can permanently damage electronic components, which do not have to be exposed directly to a static discharge for damage to occur. For instance an external static charge may be conducted through the pins of an unused, exposed connector to damage internal components. Avoid non-conducting carpets in the area surrounding the equipment. Anti-static mats, if large enough, can be placed over conventional carpeting. Man made fibres and some plastics used in chairs etc. can build up large potentials.

4.1.2 Temperature

The stability of the spectrophotometer may be affected by marked changes in temperature. For optimum operation the temperature should be maintained in the range 5 to 40°C and vary by less than 2°C.

4.1.3 Direct Sunlight

Avoid large window areas. Direct sunlight will cause heating of the spectrophotometer and will contribute to stray light.

4.1.4 Vibration

Floor vibration caused by lifts, air conditioning of refrigeration units etc., or loud acoustical noise may affect the performance of the instrument. Minimise this situation wherever possible.

4.1.5 Dust

Electronic equipment should not be used in dusty areas.

4.2 Connecting the spectrophotometer to the Mains

4.2.1 Earthing (Grounding)

Before any other connection is made, the spectrophotometer must be connected to a protective earth conductor via the three-core mains cable (see Mains Cable Connection, Section 4.2.3). The mains plug must only be inserted into a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cable without a protective conductor.

WARNING: Any interruption of the protective earth conductor inside or outside the instrument is likely to make the instrument dangerous. No responsibility will be accepted for any consequences of failure to ensure adequate earthing (grounding).

4.2.2 Mains Voltage Setting and Mains Fuse

The Nicolet Evolution 500 can be operated on mains voltages of nominally (±10%) 100V, 120V, 220V and 240V, 50 and 60 Hz. Before connecting the mains cable and switching on, check and reset the selector as follows:

WARNING: The instrument must be disconnected from all voltage sources before being adapted to a different mains voltage, or when a fuse is to be renewed.

(1) Look through the window into the selector (Fig 4.1) and check that the voltage marked on the selector board and the fuse value (see 4.2.2.3) are correct for your mains supply.
If these are OK move on to section 4.2.3.
If the selection and/or fuse is not correct proceed as in (2).
Make sure that only fuses of the required current rating and specified type are used for renewal. The use of repaired fuses, and/or the short circuiting of fuse holders, will invalidate any warranty.

(2) Unplug the mains cable (if fitted) from the socket on the side panel. Slide the window up.

(3) Rotate the FUSE PULL lever downwards and remove the fuse. Check the fuse. This must be:

4A (2422 086 01428) for 220/240V mains supply.

7A semi-delay (2422 086 01435) for 100/120V mains supply.

(4) Pull out the selector card (Fig 4.1) using a small tool in the removal hole (or use a small pair of pliers).

(5) Turn the card to position the desired voltage on the top left side of the card (Fig 4.1). Push the card firmly into the card slot.

(6) Rotate the FUSE PULL lever upwards and push the correct value fuse (see (3.)) into the clips.

(7) Refer to Section 4.2.3 before plugging in the mains cable.

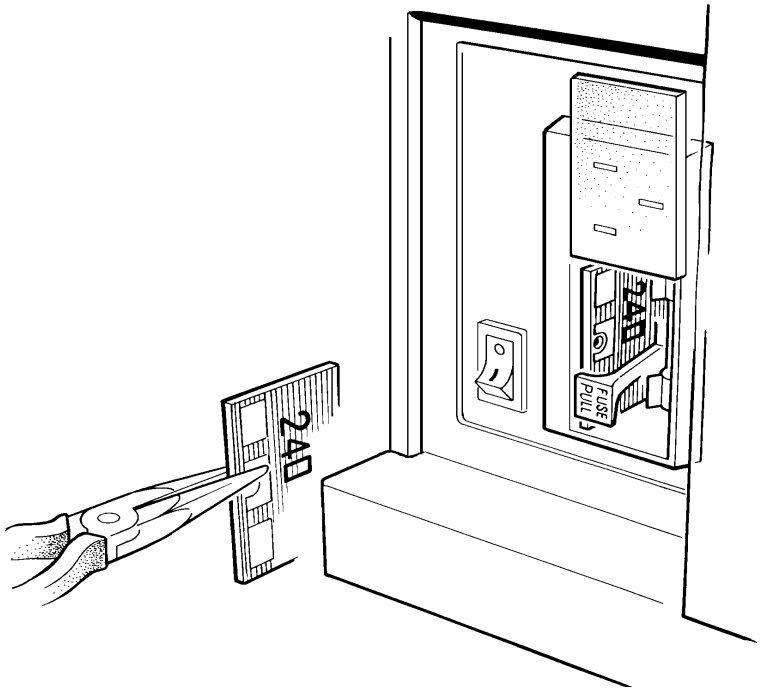


Fig 4.1 Mains connector

4.2.3 Mains Cable Connection

If your mains cable is fitted with a suitable mains plug, carry out operations (3) and (4) below.

If you have been supplied with a mains cable with no plug fitted, or the fitted plug is unsuitable for your environment, carry out operations (1) to (4) below.

(1) If a plug is fitted, remove it.

(2) Fit a suitable 3-pin plug to the free end of the cable, connecting individual leads as follows:

Plug pins	**European Code**	**N. American Code**
LIVE (L)	Brown	Black
NEUTRAL (N)	Blue	White
EARTH/GROUND (E)	Green/Yellow	Green

A good earth is essential both for satisfactory operation of the instrument and the safety of the user.

(3) Make sure the Power ON/OFF switch is in the OFF position. Plug the mains cable into the POWER socket at the rear of the instrument (Fig 4.1).

(4) The mains plug may be inserted into a socket outlet provided with a protective earth contact when all installation work has been done.

4.3 Locating the Computer (if appropriate)

If there is no requirement to position a computer move on to section 4.5

The computer is designed for use on a normal desk or bench which should be of sturdy construction and of sufficient size to accommodate the computer base unit. There should be at least 30mm clearance from any obstruction to allow the circulation of air through the cooling vents. Ensure there is ample space at the rear of the base unit for cables.

The computer should be operated in a room with an atmosphere free from dust and corrosive vapours.

Note: Computer systems commissioned at Thermo Electron in Cambridge will have had the software purchased already installed on the hard disk before shipment. A sticker to this effect will be found on the monitor.

4.3.1 Using Your Own Computer

If required, you may use your own computer providing it meets the necessary specification. If in doubt contact your Local Sales Office (or Agent).

4.3.2 Locating the Computer

(1) Unpack the computer base unit where the computer is to be used. Position the unit to enable access to the rear for fitting connecting cables.

(2) Unpack the monitor and place on top of the base unit.

(3) Connect the monitor to the mains outlet on the rear of the base unit using the power lead supplied.

Note: Dependent on the computer supplied, the monitor may need to be connected directly to a mains outlet socket.

(4) Fit the video cable between the video connectors (9 pin `D' type or 15 pin mini- `D' type connector) on the base unit and the monitor.

(5) Unpack the keyboard and place it in front of and close to the base unit.

(6) Connect the keyboard to the rear of the computer base unit.

(7) Unpack the mouse and connect to its mating connector on the rear of the computer base unit.

4.3.3 Floppy Disk Drive

During transit, the computer floppy disk drive may be fitted with a cardboard blank. This is to reduce the risk of damage to the drive during shipment. Remove the blank before switching on the computer but ensure the blank is retained for future use should it be necessary to move the computer. If the cardboard blank is not available, fit an unformatted floppy disk or a known faulty disk.

4.4 Connecting the computer to the Mains

4.4.1 Earthing (Grounding)

Before making any connections, the computer must be connected to a protective earth conductor via the three core mains cable supplied. The mains connector must only be inserted into a mains outlet provided with a protective earth contact. This must not be negated by the use of an extension lead without a protective earth contact.

WARNING: Any interruption of the protective earth conductor inside or outside the instrument is likely to make the instrument dangerous. No responsibility will be accepted for any consequences of failure to ensure adequate earthing (grounding).

4.4.2 Mains Voltage Setting

Check that your computer is suitable for the mains supply it is to be used on. It is not possible to alter the mains voltage setting of the computer.

4.4.3 Mains Cable Connection

If you have been supplied with a mains cable with no plug fitted, or if the fitted plug is unsuitable, refer to operation (1) and connect a suitable plug. When fitted, carry out operations (2) and (3). If the mains cable has been supplied with a suitable plug fitted, carry out operations (2) and (3).

(1) Fit a suitable 3-pin plug to the free end of the cable, connecting the individual leads as follows:

Plug pins	European Code	N. American Code
LIVE (L)	Brown	Black
NEUTRAL (N)	Blue	White
EARTH/GROUND (E)	Green/Yellow	Green

A good earth is essential both for satisfactory operation of the instrument and the safety of the user.

(2) Make sure the computer ON/OFF switch is in the OFF position and plug the mains cable into the mains socket at the rear of the computer.

(3) Provided all installation work has been done as detailed in Section 4.3, insert the cable mains plug into a mains outlet provided with a protective earth contact.

4.5 Locating the Printer/Plotter (if appropriate)

If there is no requirement to position a printer/plotter move on to Section 5 - Interconnections. Locate the printer/plotter adjacent to the other components of the system, ensuring that the environment conforms to the environmental requirements detailed in the manufacturer's handbook.

4.6 Connecting the Printer/Plotter to the Mains

This section applies to the printer/plotter irrespective of whether it is connected to the spectrophotometer or a PC.

4.6.1 Earthing (Grounding)

Before any other connection is made, the printer must be connected to a protective earth conductor via the three-core mains cable (see Section 4.6.3). The mains plug must only be inserted into a socket outlet provided with a protective earth contact. This protective action must not be negated by the use of an extension cable without a protective conductor.

WARNING: Any interruption of the protective earth conductor inside or outside the instrument is likely to make the instrument dangerous. No responsibility will be accepted for any consequences of failure to ensure adequate earthing (grounding).

4.6.2 Mains Voltage Setting

Check that your printer/plotter is suitable for the local mains supply. It is not possible for the user to alter the mains voltage setting.

Note: The Epson printer is available in 240V, 220V or 110V versions.

4.6.3 Printer/Plotter Mains Cable Connection

If you have been supplied with a mains cable with no plug fitted, or if the fitted plug is unsuitable, refer to operation (1) and connect a suitable plug. When fitted, carry out operations (2) and (3). If the mains cable has been supplied with a suitable plug fitted, carry out operations (2) and (3)

(1) Fit a suitable 3-pin plug to the free end of the cable, connecting individual leads as follows:

Plug pins	**European Code**	**N. American Code**
LIVE (L)	Brown	Black
NEUTRAL (N)	Blue	White
EARTH/GROUND (E)	Green/Yellow	Green

A good earth is essential both for satisfactory operation of the printer and the safety of the user.

(2) Make sure the Power ON/OFF switch is in the OFF position. Plug the mains cable into the POWER socket at the rear of the printer.

(3) Provided all installation work has been done as detailed in this section and in the printer manual, insert the mains plug into a socket outlet provided with a protective earth contact.

SECTION 5 - SYSTEM INTERCONNECTIONS

This section covers the complete Nicolet Evolution 500 system interconnections. Figs 5.1 and 5.2 provide diagrammatic representations of the interconnections required for the installation of each version of the Nicolet Evolution 500.

5.1 Connecting up a Standalone Nicolet Evolution 500 based system

On the Nicolet Evolution 500 Standalone, only one device can be connected. The device must therefore be fitted with a serial interface adapter.

Connect the required printer or plotter to the 9-way `D' type connector at the side of the Spectrophotometer. Ensure that the connectors are firmly secured to their appropriate mating connectors at both ends of the cable. No cables are supplied with the Nicolet Evolution 500 instrument (unless the printer is supplied by Thermo Electron). If you supply your own serial printer, you must supply your own printer cable.

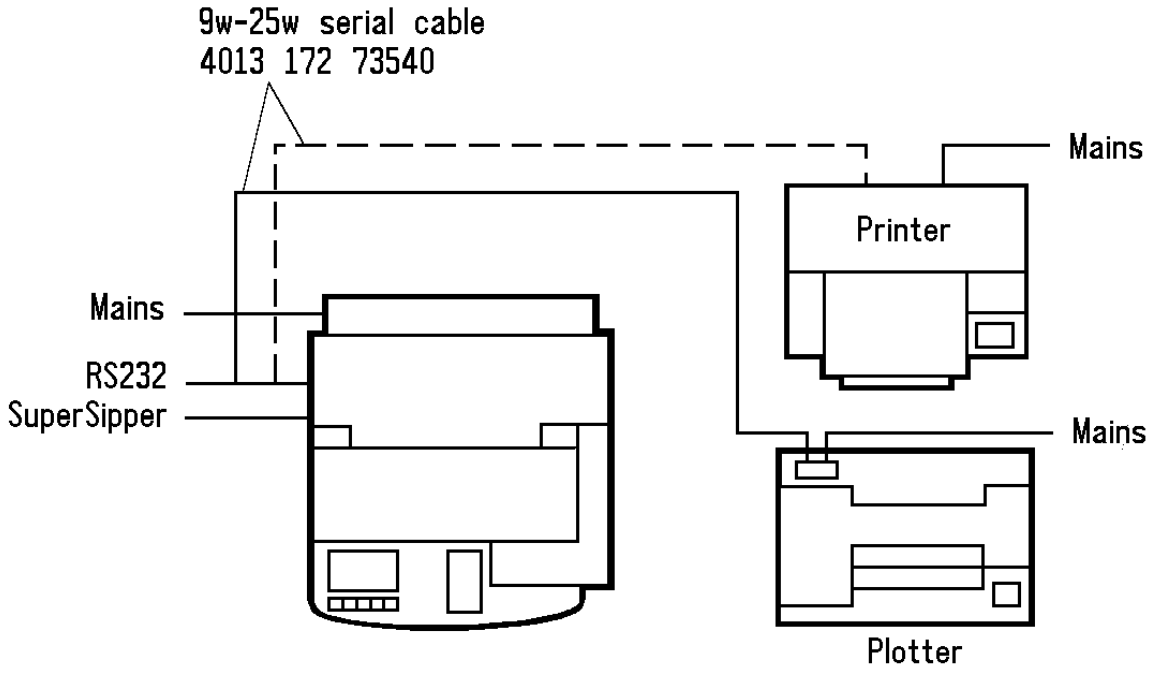


Fig 5.1 Connections to a Standalone Nicolet Evolution 500 system

5.1.1 Setting up the Printer/Plotter

This Section gives specific details concerning the setting up of printers/plotters for use with the Local Control software on a Nicolet Evolution 500 UV-Visible Spectrophotometer.

The printers supported are as follows:

Epson 9 pin dot matrix printer (generic driver)

Hewlett Packard HP Deskjet printer (generic driver)

Hewlett Packard HP Laserjet printer (generic driver)

Hewlett Packard HP Deskjet 400 and 690C printers

Hewlett Packard HP Paintjet 3630A printer

Hewlett Packard HP Plotter

Printers not on the above list that claim Epson 9 pin / 24 pin / ESC/P or HP PCL (Programming Control Language) Level 3 compatibility should work with the instrument but are not guaranteed to do so and are therefore not supported. If in doubt contact your local Thermo Electron approved Customer Support Organisation.

Note: Printers designed to work only in a Windows environment are not compatible with Local Control Software.

Depending on the printer/plotter, it may be fitted with both a parallel and serial connector. The serial connector consists of two horizontal rows of pins, 13 on the top and 12 on the bottom. The parallel connector is a 36 way connector having 18 connecting pins in each row. Only an appropriate mating connector can be fitted to either connector.

For use directly with a Nicolet Evolution 500 Spectrophotometer the printer/plotter must have a serial interface for connecting it directly to the Spectrophotometer. This may involve setting the value of a number of parameters (see printer/plotter handbook). The serial printer parameters required are shown in Table 5.1. Alternatively this capability may be achieved using a parallel to serial converter.

For use with a computer the printer parallel interface connects directly to the parallel interface connector (LPT1) on the computer base unit (Section 5.2).

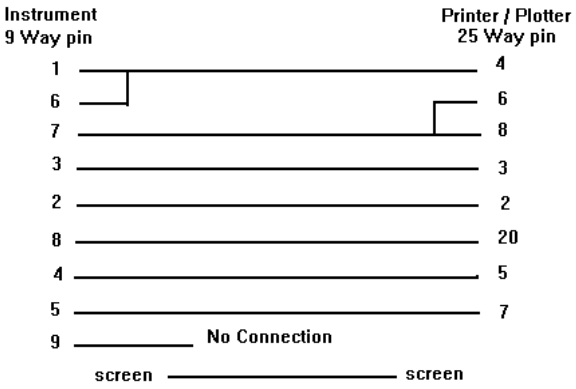
Table 5.1 Printer Serial Parameters

Epson and HP Paintjet		**HP Laserjet**	
Baud rate:	9600	I/P-O/P PORT:	Serial
Parity:	None	BAUD RATE:	9600
Data:	8 bits	ROBUST XON:	Off
Stop bit:	1 bit	DTR POLARITY:	High

5.1.2 Using your own Printer

If you are supplying you own printer, you need to acquire a suitable cable to connect it to the instrument. The cable should be a null modem serial interface cable with a 9 way 'D' type female connector for connection to the instrument. The connections to the 9 or 25 way printer connector should be as listed in Table 5.2.

Table 5.2 Serial Printer/Plotter cable
(4013-172-73540)



5.2 Connecting up a Computer based Nicolet Evolution 500 system

On a computer based Evolution 500 system the printer supplied must be connected to parallel interface connector 1 (LPT1) whilst a plotter must be connected to serial interface connector (COM2).

(1) Using the cable supplied with the PC software, connect the Evolution 500 spectrophotometer to the computer as shown on Fig 5.2.

(2) Check all PC interconnections previously connected. (Section 4.3.2.)

Ensure the connectors are firmly secured to their respective mating connectors by tightening the jackscrews evenly on each side.

(3) If required, connect the printer supplied to the parallel interface connector LPT1 on the rear of the computer base unit using the cable supplied with the printer. At one end of the cable is a 25-way `D' type plug. Fit this into the PARALLEL 1 (LPT1) socket of the computer drawing the plug carefully into the socket by tightening each jackscrew alternately, a turn at a time. Connect the 36-way plug at the other end of the cable to the mating socket on the printer. Secure in position using the clips on the printer.

(4) If required, connect the plotter to the serial interface connector COM2 on the rear of the computer base unit using the cable supplied with the plotter. Ensure the connectors are firmly secured to their appropriate mating connectors at both ends of the cable.

5.2.1 Setting up the Printer/Plotter

Various printers/plotters may be used, each being supplied with its own manual which should be consulted for full instructions on setting up and operation.

When using Vision software on the PC, any parallel printer supported by Windows ™ can be used to obtain hard copy output.

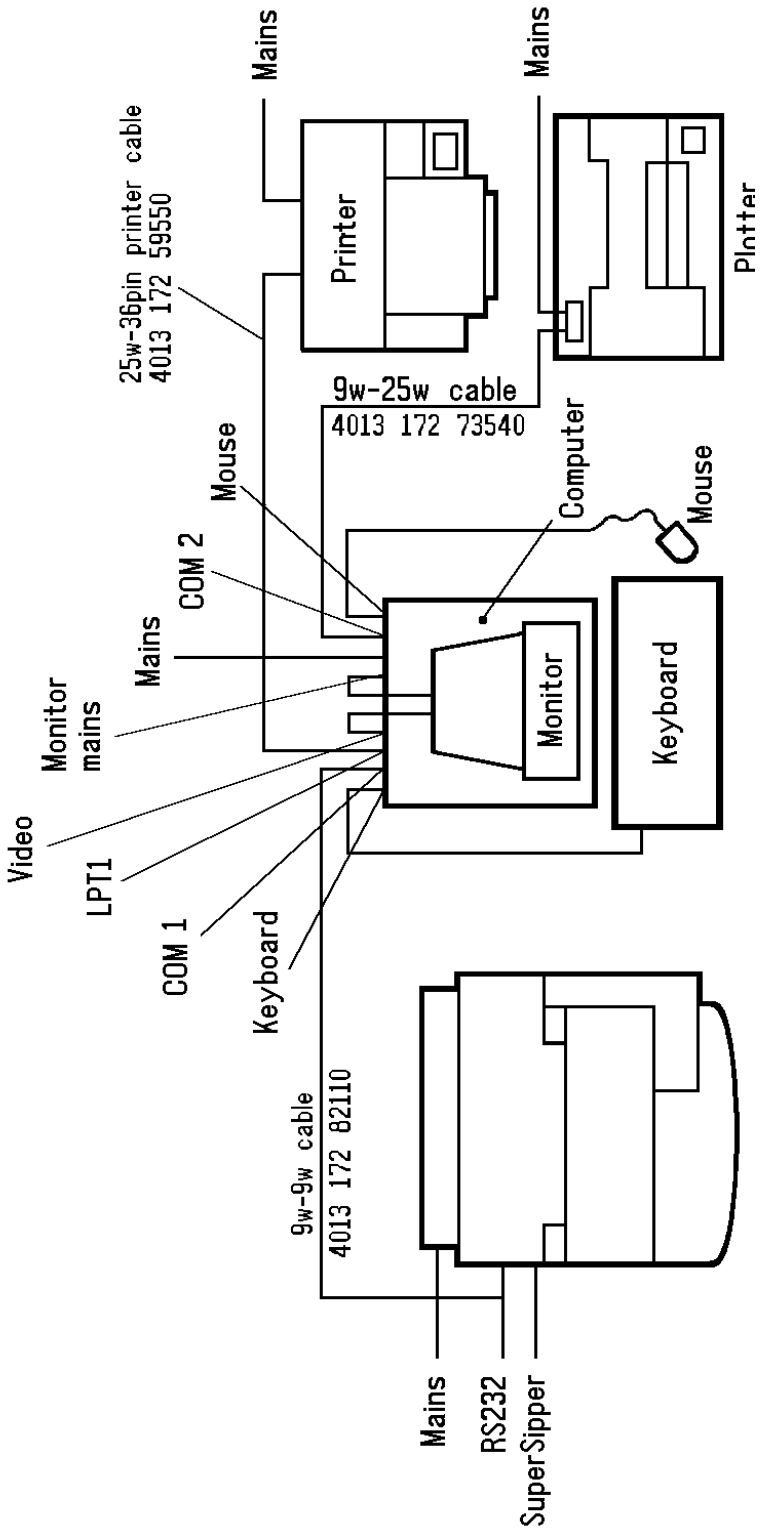


Fig 5.2 Connections to a PC based system

5.3 System Interconnection Summary

PC Based Evolution 500 system

From	To
Spectrophotometer	Computer serial port COM1
Plotter	Computer serial port COM2
Printer	Computer parallel port LPT1
Monitor signal connector	Computer monitor connector
Mouse	Computer mating connector
Keyboard	Computer keyboard connector

Evolution 500 based system

From	To
Evolution 500	Required printer or plotter (serial connector)

Note: (1) To connect any printer or plotter to the Spectrophotometer, it must be fitted with a serial interface adapter.

(2) If connection of both a printer and plotter to a PC based Evolution 500 system is required, the mouse type used must be a 'bus' mouse, not a 'serial' mouse.

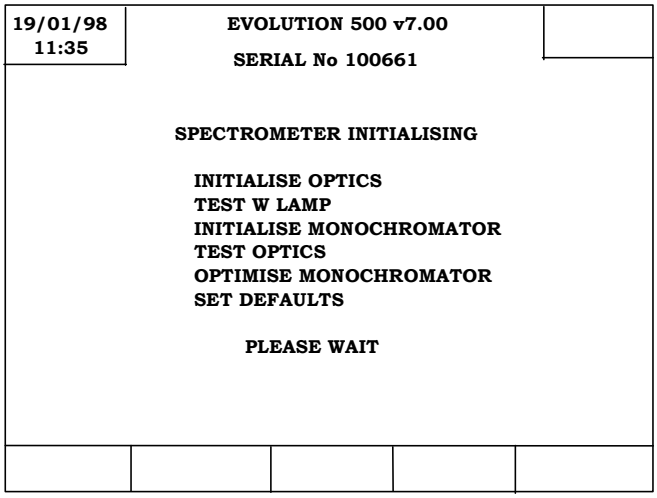
SECTION 6 - SYSTEM POWER UP

This section details the application of power to a correctly configured system, and the system responses the user should expect in normal operation.

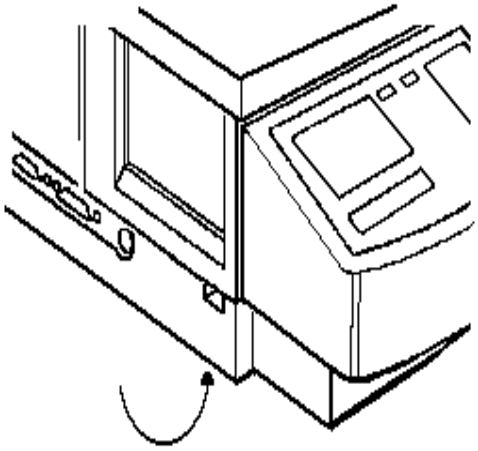
6.1 Powering up a Standalone based Nicolet Evolution 500 system

(1) Apply power to the spectrophotometer. Do not apply power to any connected PC.

The green power on LED should be illuminated. The LCD display will be blank initially, and after 1 - 2 minutes should appear as below:



Note: Should the display 'light-up' but no text appear after the delay noted above, check the LCD contrast control underneath the spectrophotometer. Rotate fully to the extremes of the available movement. At some point the above display should appear.



TIP - IF YOU DON'T SEE ANY DISPLAY?

ROTATE THE THUMBWHEEL UNDER THE INSTRUMENT UNTIL THE DISPLAY RE-APPEARS

(2)The spectrophotometer should now begin to initialize.

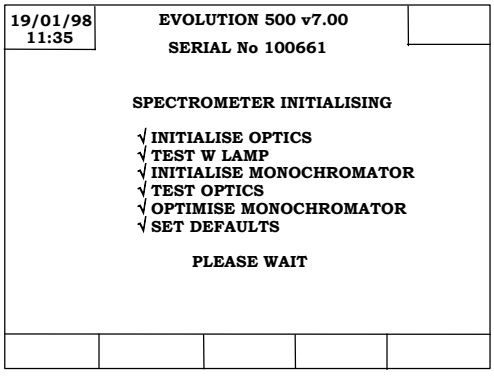
The following processes are carried out automatically by the instrument during the initialization sequence. Each stage is marked with a √ pass mark when it has been satisfactorily completed.

Initialize Optics	Filter wheel is driven to end stop. Opto-sensor is checked. Filter is set to clear position. Initialize slits: Slit plate driven to end stop, then back to 1.5nm position. Initialize self test unit (if fitted): Self test wheel driven to end stop back to clear position Wavelength drive is driven back to the end stop sensor.
Test tungsten lamp.	The tungsten lamp is turned on and supply voltage checked. If tungsten lamp fails to operate deuterium lamp is switched on.
Initialize Monochromator	The monochromator is driven to about 500 nm to ensure light will get through.
Test optics.	The lamp change mirror is set up to peak the tungsten lamp energy. (If the tungsten lamp has failed the deuterium lamp is peaked)
Optimize monochromator	Finds the zero order peak
Set defaults	Switches on and peaks up deuterium lamp if D_2 lamp flag is set. Tests slits. Tests absorbance filters if self test fitted. Drives to default wavelength.

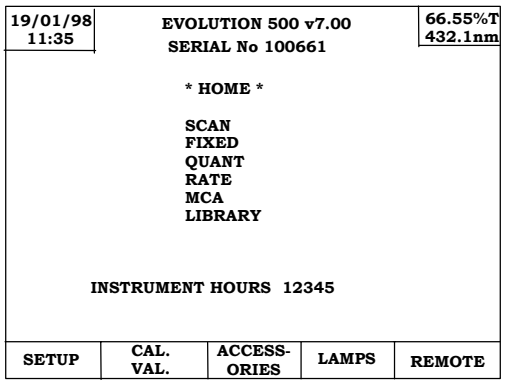
Completion of Initialization

Once all tests have been complete, the display shown below will appear briefly.
The instrument will then switch automatically to the Home page.

Completed initialization page



Home page



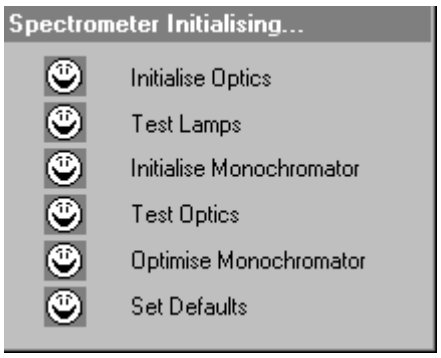
APPEARANCE OF BOTH THESE PAGES MEANS THAT THE INSTALLATION IS SUCCESSFUL.

6.2 Powering up a PC Controlled system using VISION software

It is assumed that the VISION software has been installed following the procedures specified in the User documentation.

(1) Turn on the PC and start up VISION by double clicking on the VISION icon on the Windows desktop.

(2) Now turn on the Evolution 500 Spectrophotometer - the window displayed below should appear.



As each stage of the initialisation is successfully completed a yellow ☺ pass symbol will appear in the box alongside each test. At the end of initialization this window disappears.

(3) Once the initialisation process has finished, it should be possible to observe a live, changing status display.

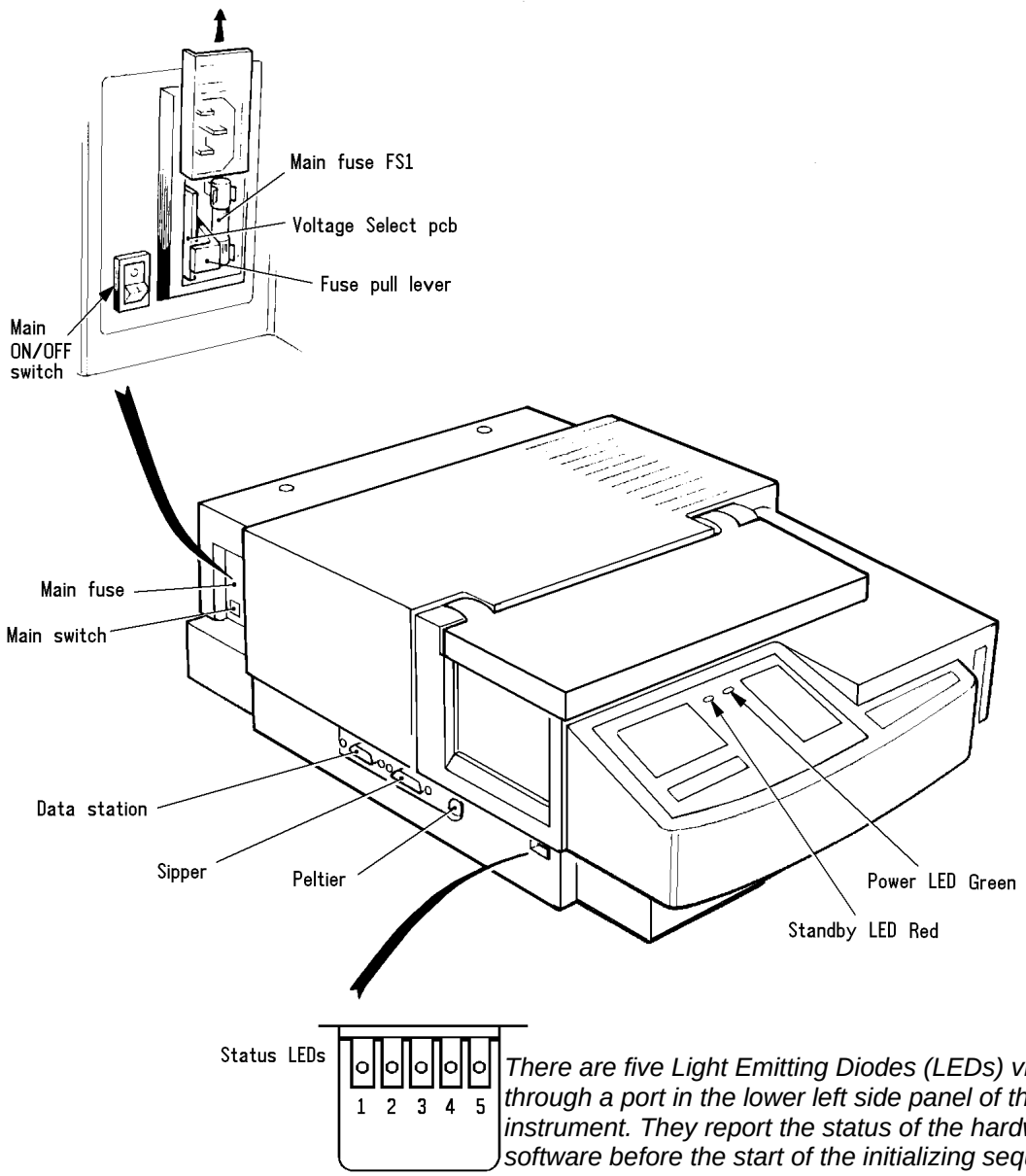
IF BOTH DISPLAYS CAN BE OBSERVED THEN THE INSTALLATION IS SUCCESSFUL.

SECTION 7 - TROUBLESHOOTING

This section offers guidance to the user in the event of operating problems. Where possible remedial action is suggested. However, it deals only with those items of service which can be safely carried out by the operator. Any service beyond that detailed should be carried out by a Thermo Electron approved service engineer.

7.1 Fault Finding

Symptom	Comment and/or Suggested Action
The instrument fails to respond. The front panel LEDS remain off	Check that the instrument is plugged in and switched on. Check the integrity of the mains lead and the fuse in the plug. Check that the instrument mains fuse has not blown. (See Section 10.5) Check that the voltage selector is correctly set.
The instrument fails to respond. Display is blank. The front panel Red LED is on.	The instrument is in standby mode. Switch off and then on, or activate via RS232 and remote control software.
The instrument fails to power up correctly. One or more side LEDs remains on (See Fig 7.1)	LED 1. Power Supply fault. Check internal fuses. (See Section 10.5) LED 2. Boot code fault. LED 3. RAM fault. LED 4. Error in configuration data. LED 5. Flash EPROM fault. These faults cannot be dealt with by the user. Please note which LED remains on and call Thermo Electron Customer Support.
The instrument fails to initialize (Error 3027) NB Failure to initialize will cause several other consequent errors as well as 3027	Check that both beams are clear. The instrument will not initialize correctly if anything is left in either beam at power up.
The front panel green LED is on but the display is blank.	Check contrast control (lower left side, see Section 6.1)
Error 3014	Change the tungsten lamp. See Section 10.3
Error 3008	Change the deuterium lamp. See section 10.4



There are five Light Emitting Diodes (LEDs) visible through a port in the lower left side panel of the instrument. They report the status of the hardware and software before the start of the initializing sequence. All LEDs are set to "ON" at power up and then each one is turned off as the system it reports is found to be OK.

Fig 7.1 Evolution 500 input and output connections and status LEDs

7.2 Evolution 500 Error Numbers and Messages

When the instrument is switched on the software initializes the instrument and then continues to monitor its operation when in use. If a problem occurs a software message will be displayed with an error code.

Warning messages indicate that data quality may be impaired.

In the event of a fatal error data collection ceases; user intervention is required.

Self help by the user is possible in response to some error messages and these are listed below. If the measures suggested fail, or the error code is not included here, please contact Thermo Electron Customer Support, quoting the relevant error message number.

7.2.1 Warnings

These warnings may be generated when the instrument is under computer control.

W1017
The requested command to the spectrophotometer cannot be run as it is busy running another command.

W1026 SELF TEST NOT PRESENT
An attempt has been made to move self test wheel when the accessory is not fitted.

W1037 CLOCK FAULT SEE USER MANUAL
The battery in the real-time clock chip has failed. This should be replaced by a qualified engineer.

7.2.4 Fatal Errors

E3001 CELL PROGRAMMER NOT PRESENT
The cell hardware is not connected.

E3002 CELL PROGRAMMER MOVE
Failure moving the cell transport. Either the mechanism has reported a failure, or the bench has timed out trying to move it. **Ensure that nothing is jamming the cell programmer.** If the fault persists call Thermo Electron Customer Support.

E3008 D_2 LAMP PROBLEM

Failure attempting to switch on the Deuterium lamp. Three attempts have been made to strike the lamp. **This indicates either that the lamp requires replacing, or a power supply failure, or a blown fuse. See Sections 10.4, 10.5.**

E3010, E3011, E3014, E3015 W LAMP PROBLEM
Check the tungsten lamp. If it has failed replace it. (See Section10.3). Try switching the instrument off, then on again after 10 seconds. If this does not clear the error call Thermo Electron Customer Support.

E3016 ADC

The ADC reading for 10V reference signal is less than expected. There is either a problem with the reference voltage itself or the ADC. Try switching the instrument off, then on again after 10 seconds. If this does not clear the error call Customer Support.

E3022 D_2 FAILED

The monochromator is at a wavelength where the D_2 lamp is required but after several tries it has not struck. See E3008 above.

E3026 RS232C FAILED

The spectrophotometer has not responded. Data has been lost. **Check cable connections between instrument and computer** before calling Customer Support.

E3027 CHECK BEAMS ARE CLEAR

During optical initialization it has not been possible to find the peak position of the lamp or zero order position of the monochromator. Therefore the instrument cannot initialize. **Check that nothing has been left in either the sample beam or the reference beam. Try restarting the instrument** before calling Customer Support.

E3046 CLOCK FAULT

Calendar clock chip appears to have stopped running. **Try re-setting a new time.** If unsuccessful call Customer Support.

E3047 CALIBRATION FAULT

Calibration parameters retrieved from the EEPROM are out of range. **A mercury lamp calibration is required. See Local Control Software Manual, Section 9.6**

E3048 CALIBRATION FAULT

A calibration line was not found during a calibration. Try again. If problem persists call Customer Support.

E3049 CALIBRATION FAULT

The calibration coefficients do not fit the actual measured data. **Run mercury lamp calibration again. (See Local Control Software Manual Section 9.6).** If the problem persists call Customer Support.

E3050 CALIBRATION FAULT

The calibration coefficients were not stored in the EEPROM correctly. **Try running the mercury lamp calibration again (See Local Control Software Manual Section 9.6).** If the problem persists call Customer Support.

E3051 CALIBRATION FAULT

The wavelength calibration failed. **Try running calibration procedure again. (See Local Control Software Manual Section 9.6).** If the problem persists call Customer Support.

E3052 STANDBY MODE

The spectrophotometer has received a new command while in standby mode. **The spectrophotometer requires the WAKEUP command from the Vision Software before it can action further commands. See Section 9.9 of this Manual.**

E3053 DAC OFFSET
During optical initialization it was not possible to null the offsets on the pre-amplifier signal. **Check that the covers are fitted correctly and that the sample compartment is light tight, then try again.** If the fault persists call Customer Support.

E3054 CELL PROGRAMMER
The cell programmer has stalled. **Check that nothing is jamming the transport mechanism.**

E3055 CELL PROGRAMMER TIMEOUT
The cell programmer has not moved to the required cell position in the time allocated. **Check that nothing is jamming the transport mechanism.**

E3056 NOT INITIALISED
The spectrophotometer has become un-initialised. **Try switching the instrument off then on again and allow it to re-initialise.** Call Customer Support if the problem persists.

E3058 DAC ERROR
Offsets cannot be correctly nulled during gain calibration. **Perform a Lifetime Initialisation. (See Section 9.3.1 of this Manual).** If the problem persists call Customer Support.

E3059 GAIN ERROR
The instrument gains are not ascending from minimum to maximum as expected. This can occur during a gain calibration if the starting conditions are not correct or if there is a light leak. **Check for light leaks, then perform a lifetime initialisation, (See Section 9.3.1 of this Manual), and repeat the gain calibration.** If the problem persists call Customer Support.

E3060 DEFAULT BASELINE
There is no valid baseline in the non-volatile memory. **Run a new default baseline using the appropriate software commands. (See Section 9.7 in the Local Control Software Manual)**

E3062 EHT INHIBIT
The EHT supply is inhibited. This is probably due to the sample compartment lid being opened. (See Section 9.4.4 of this Manual). **Ensure that the Sample Compartment lid is properly closed.**

E3064 EHT CALIBRATION ERROR
The EHT calibration failed. This may be because the lid was opened. **Please ensure that the lid is properly closed, repeat the EHT calibration, (See Section 9.3 of the Local Control Software Manual),** and call Customer Support if the fault persists.

E3065 STORED EHT VALUE PROBLEM
The checksum of one or other or both the EHT data stores is incorrect. **Please run an EHT calibration for both the Normal and High Energy tables(See section 9.5.2 of this Manual, Section 9.3 of the Local Control Software Manual).** Contact Customer Support if the problem persists.

E3066 MONOCHROMATOR ERROR
The monochromator has been requested to move a number of steps that are out of range. **Please re-run a Mercury Wavelength Calibration, (See section 9.6.1 of the Local Control Software Manual)** and call Customer Support if the problem persists.

E3067 MONOCHROMATOR ERROR
The present calibration cannot be supported by the hardware. **Please rerun a Mercury Wavelength Calibration, (See section 9.6.1 of the Local Control Software Manual),** and call Customer Support if the problem persists.

E3068 SAMPLE BEAM GAIN PROBLEM
The sample channel gain cannot be set low enough to avoid saturating the detector. In general this error arises if the measurement is not being carried out under the same conditions as the EHT calibration. This can be caused by a light leak. It can also arise after a lamp replacement. Although it is not normally necessary to recalibrate the EHT tables, this will need to be done if the new lamp is significantly brighter than the old one. **Please check that the lid is properly closed. If this fails try recalibrating the EHT (See Section 9.3 of the Local Control Software Manual)**

E3069 REFERENCE BEAM GAIN PROBLEM
This error is analogous to E3068, above.

E3070 DARK SIGNAL PROBLEM
The dark signal is too large. This may be due to a light leak but can also occur on PMT instruments when the EHT has not been optimised for the current operating conditions. **Please check that the lid is properly closed. If this fails try recalibrating the EHT (See Section 9.3 of the Local Control Software Manual)**

E3071 DARK SIGNAL PROBLEM
The dark signal cannot be correctly nulled. Usually caused by a light leak. **Please check that the lid is properly closed. If this fails try recalibrating the EHT (See Section 9.3 of the Local Control Software Manual)**

E3072/3 EEPROM FAILURE
An error was reported when writing data to the configuration EEPROM. **Repeat the command,** and call Customer Support if the problem persists.

E3074 DARK GAIN LOW
The dark signal is too high, it is over range at minimum gain. **Ensure that there are no light leaks then perform an EHT calibration on the system (See Section 9.3 of the Local Control Software Manual)** and call Customer Support if the problem persists.

E3075 DARK GAIN HIGH
The dark signal is smaller than expected. This could be due to the EHT being too low. **Perform an EHT calibration on the system (See Section 9.3 of the Local Control Software Manual)** and call Customer Support if the problem persists.

SECTION 8 - SYSTEM DESCRIPTION

The system comprises three main components, a Nicolet Evolution 500 spectrophotometer, a controlling device and an output device.
The controlling device is either a built-in LCD and Keypad running Local Control software or an external PC running VISION***pro*** or VISION***security*** software.

8.1 System Composition

8.1.1 Nicolet Evolution 500 Spectrophotometers

Evolution 500 PC Control with VISION***security*** software 10 50 0101

Evolution 500 true double beam scanning UV-visible spectrophotometer: single photomultiplier detector; Variable Bandpass (0.2 to 4nm); Wavelength range 190 – 900nm; Self-optimizing, sealed and quartz coated optical system; Two 1 – 50mm pathlength cell holders; Computer-ready with built-in RS232C port; Built-in initialization and error diagnostics.
VISION***security*** PC software; Scanning, Quantification, Multiple wavelength, Ratio and Multicomponent Analysis; Multiple security options, capability of achieving 21 CFR Part 11 and electronic signatures, full audit trails and data traceability; Method and results storage; Advanced results calculation; Multiple language support; Rate, Advanced Kinetics Analysis and DNA melting (optional);
Instrument verification and calibration (optional); wide range of accessories (optional); 29kg; 248x552x584mm; 115/230v and 60/50Hz.

Evolution 500 PC Control with VISION***pro*** software 10 50 0201

Evolution 500 true double beam scanning UV-visible spectrophotometer: single photomultiplier detector; Variable Bandpass (0.2 to 4nm); Wavelength range 190 – 900nm; Self-optimizing, sealed and quartz coated optical system; Two 1 – 50mm pathlength cell holders; Computer-ready with built-in RS232C port; Built-in initialization and error diagnostics.
VISION***pro*** PC software; Scanning, Quantification, Multiple wavelength, Ratio and Multicomponent Analysis; Security options; Method and results storage; Advanced results calculation; Multiple language support; Rate, Advanced Kinetics Analysis and DNA melting (optional);
Instrument verification and calibration (optional); wide range of accessories (optional); 29kg; 248x552x584mm; 115/230v and 60/50Hz.

Evolution 500 Local Control 10 50 0301

Evolution 500 true double beam scanning UV-visible spectrophotometer: single photomultiplier detector; Variable Bandpass (0.2 to 4nm); Wavelength range 190 – 900nm; Self-optimizing, sealed and quartz coated optical system; Two 1 – 50mm pathlength cell holders; Computer-ready with built-in RS232C port; Built-in initialization and error diagnostics.
Local Control software; Scanning, Quantification, Multiple wavelength, Ratio and Multicomponent, kinetics and life science analysis; Multiple access level security authorization; Advanced results calculation; Multiple language support;;
Standard floppy disk drive; method and results storage; Instrument verification and

calibration (optional); Wide choice of PC software (optional); Wide range of accessories (optional); 29kg; 248x552x584mm; 115/230v and 60/50Hz.

8.1.2 Evolution 500 Cell Holders

100mm Pathlength rectangular cell holder	9423 UV5 1240E
Variable Path Length Cell Holder	9423 UV5 1200E
100mm Pathlength cylindrical cell holder	9423 UV5 1210E
Thermostatted single cell holder	9423 UV5 2200E

8.1.3 Sample Handling Accessories

8 Cell Programmer	9423 UV6 2200E
Multi Function Cell Holder for Above	9423 UV5 3200E
Cetac ASX510 360 position sampler for Vision Auto	9423 UV6 4650E
Cetac ASX510 160 position sampler for Vision Auto	9423 UV6 4610E
Gilson 222XL Autosampler for Vision Auto	9423 UV6 4400E
SuperSipper	9423 UV6 4200E
(Requires tubing pack and flowcell)	
SuperSipper Standard Tubing Pack	9423 UV6 4210E
SuperSipper Acid Tubing Pack	9423 UV6 4220E

Flowcells
Any of these cells can be used with the SuperSipper

10mm	Compact	UV Silica	9423 168 14601
		Glass	9423 168 14591
10mm	Standard	UV Silica	9423 168 14351
		Glass	9423 168 14341

8.1.4 Software

VISION***security*** PC software 10 04 0301
Multiple security options: Capable of achieving 21 CFR Part 11 and electronic signatures, full audit trails and traceability.
Scanning, multiple wavelength, ratio, quantification and multicomponent analysis applications.
Scan: Absorbance, $\log_{10}$ A, %T, %R, 1^{st}-4^{th} derivative; 100 point peak and position pick; +, -, x, / spectra by factor or spectra.
Fixed: Up to 10 wavelengths, Normal, +, -, x, / or peak height modes.
Quant; Up to 50 standards, 3 replicates, 4 curve fits; single wavelength, dual wavelength, peak height or factor modes.
MCA: Up to 20 standards, 20 components.
Advanced Results Calculation with built-in spreadsheet applies mathematical functions to multiple batches, samples or standards.
WYSIWYG report composer. On-line Help system. Operates with Windows 2000/NT4 or 98/2000/NT4 with a NT/2000 network. Includes RS232C cable.

VISION***security*** PC software – 5 User Licence	10 04 0341
Upgrade to VISION***security*** from an earlier VISION version	10 04 0331
VISION***pro*** PC software Scanning, multiple wavelength, ratio, quantification and multicomponent analysis applications. Scan: Absorbance, $\log_{10}$ A, %T, %R, 1^{st}-4^{th} derivative; 100 point peak and position pick; +, -, x, / spectra by factor or spectra. Fixed: Up to 10 wavelengths, Normal, +, -, x, / or peak height modes. Quant; Up to 50 standards, 3 replicates, 4 curve fits; single wavelength, dual wavelength, peak height or factor modes. MCA: Up to 20 standards, 20 components. Advanced Results Calculation with built-in spreadsheet applies mathematical functions to multiple batches, samples or standards. WYSIWYG report composer. Security options. Method and results storage. Operates under Windows 98, 2000 or NT. Multiple language support. Includes RS232C cable.	10 04 0101
VISION***pro*** PC Software 5 User licence	10 04 0121
Upgrade to VISION***pro*** from an earlier VISON version	10 04 0121
VISION***life*** PC software option Rate, Advanced Kinetics and DNA melting analysis. Requires VISION***pro*** or VISION***security***.	10 04 0201
Upgrade to VISION***life*** from an earlier VISION Rate version Requires VISION***pro*** or VISION***security***.	10 04 0221
UVCalc Bio for Local Control Systems	9423 UV8 7050E
UVCalc Aqua for Local Control Systems	9423 UV8 7100E

8.1.5 Computers

Pentium PC o/s Windows NT (220/240V)	9423 UV7 0500E
Pentium PC o/s Windows NT (110/130V)	9423 UV7 0510E
Pentium PC o/s Windows 2000 (220/240V)	9423 UV7 0600E
Pentium PC o/s Windows 2000 (110/130V)	9423 UV7 0610E

If you supply your own PC to run the VISION software it must have the following minimum specification:

Pentium processor, 64 Mb RAM
100 Mb Hard Disk, 1.44 Mb floppy disk drive
2 COMM ports, parallel port
SVGA graphics adapter and monitor
VISION***pro*** - Windows 98/2000/XP or NT4
VISION***security*** – Windows 2000 or NT4. The VISION***security*** Client software may be run on a Windows 98 PC in conjunction with an NT/2000 network.

9W-9W generic null modem UV to PC cable	4013 172 82111

8.1.6 Lamps

Evolution 500 W Lamp	9423 UV9 0001E
Evolution 500 D_2 Lamp	9423 UV9 0002E

8.1.7 Calibration Accessories

Calibration Validation Unit - NPL	9423 UV6 1250E
Recalibration of CVU - NPL	9423 UV9 1200E
Calibration Validation Unit - NIST	9423 UV6 1260E
Recalibration of CVU - NIST	9423 UV9 1260E
Validator 5 Log Book	10030101
Dsolve dissolution software version 2.0 - Spare IQ documentation	10040871
Dsolve dissolution software version 2.0 - OQ documentation	10040881
Dsolve autosampler and dissolution software version 2.0 - OQ documentation	10040931
Set of 9 calibrated/traceable absorbance filters	9423 179 38091
Recalibration of 9 certified absorbance filters	4013 229 89811
Set of 4 calibrated/traceable absorbance filters	9423 185 03001
Recalibration of 4 certified absorbance filters	4013 229 89851
Set of 2 calibrated/traceable wavelength filters	9423 185 03111
Recalibration of 2 certified wavelength filters	4013 229 89841
Stray light filter, NaI, 260nm cut-off	9423 UV9 5500E
Stray light filter, KCl, 200nm cut-off	9423 UV9 5520E
NTRM Filter set 1 (930)	9423 CRM 9300E
NTRM Filter set 2 (1930)	9423 CRM 1930E
NTRM Performance Verification Set	9423 CRM 9400E
Recalibration of NTRM 930	9423 UV9 1760E
Recalibration of NTRM 1930	9423 UV9 1860E
Recalibration of NTRM Performance Verification Set	9423 UV9 1660E
Set of 2 sealed potassium dichromate solutions	9423 UV9 5100E
Set of 6 sealed potassium dichromate solutions	9423 UV9 5200E
Recalibration for a set of 2 sealed potassium dichromate cells	9423 UV9 5120E
Recalibration for a set of 6 sealed potassium dichromate cells	9423 UV9 5220E
UV Absorbance filters – set of 5	9423 UV9 5530E
UV Wavelength filter	9423 UV9 5540E
Evolution 500 Hg Lamp Accessory	9423 UV9 0023E
Self Test	9423 UV6 1200E
Filter and attenuator set (uncertified)	9423 179 08501

8.1.8 Optical Accessories

Integrating Sphere	9423 UV5 5000E
Powder Cup for Integrating Sphere	9423 UV5 5010E
Variable Angle Specular Reflectance accessory	9423 UV5 5101E

8.1.9 Output Devices

Colour inkjet printer (220/240V).	9423 UV7 3500E
Colour inkjet printer (110/130V).	9423 UV7 3510E
Laser printer 220/240v	9423 UV7 3600E
Laser printer 110/130v	9423 UV7 3610E
Serial to parallel printer adaptor for Nicolet Evolution 500	9423 UV7 1400E

8.1.10 Documentation

Spare Evolution 500 user manual	10 05 0111
Spare Evolution 500 Local Control software manual	10 50 0311
VISION***security*** Spare PC User manual	10 04 0311
VISION***security*** Spare PC Administrator User manual	10 04 0321
VISION***pro*** Spare PC User manual	10 04 0111
VISION***life*** Spare PC User manual	10 04 0211

8.2 Technical Specifications

SPECIFICATION

Wavelength Range	190-900nm
Photometric range	-0.3 to 6A
Detector	Single photomultiplier
Bandwidth	0.2, 0.5, 1, 1.5, 2, 4 nm
Best Data Resolution	0.1nm
Wavelength Accuracy[1]	± 0.3nm
Wavelength Repeatability[2]	± 0.1nm
Photometric Accuracy[3]	± 0.005 at 2A ± 0.002 at 1A ± 0.008 at 3A
Photometric Repeatability[4]	± 0.001 at 1A ± 0.002 at 2A ± 0.005 at 3A

EP Photometric Accuracy ($K_2Cr_2O_7$)[5]

235nm	0.748A ± 0.010
257nm	0.865A ± 0.010
313nm	0.292A ± 0.010
350nm	0.640A ± 0.010

NOTE: It will be necessary to add filter tolerances to these values when checking photometric accuracy.

[1] Wavelength accuracy using holmium and didymium traceable to the National Physical Laboratory.
[2] Wavelength repeatability across complete wavelength range using holmium and didymium traceable to the NPL.
[3] Photometric accuracy at 546nm using neutral density glass filters traceable to the NPL.
[4] Photometric repeatability at 546nm using neutral density glass filters traceable to the NPL.
[5] European Pharmacopoeia photometric accuracy test using potassium dichromate.

Peak - Peak Noise 500nm

0A 1.5nm	<0.0003A
1A 1.5nm	<0.0004A
2A 1.5nm	<0.0040A

Stray Light

KCl solution at 200 nm	>2.0A
NaI solution at 220 nm	<0.02 %T
$NaNO_3$ solution at 340 nm	<0.005 %T

Stability at 340nm	<0.0005 A/Hour
Baseline Flatness[6]	± 0.001A
Scan Speeds	1 - 3800nm/min, Intelliscan

Physical Specifications

Dimensions:

Height	248mm
Width	552mm
Depth	584mm
Weight	29kg

Electrical Specifications

Voltage	100, 120, 220, 240V ac. ± 10%
Frequency	50 - 60Hz
Power	350VA max.

Environmental Specifications

Temperature Range	5 - 40°C
Humidity Range	20 - 80% - non condensing
Safety	IEC1010-1
Electromagnetic Compatibility	EN50082-1

8.3 Regulatory Notices

Electrical Safety Class

This apparatus has been designed and tested in accordance with Safety Class I requirements of IEC Publication No. 1010-1, safety requirements for electrical equipment for measurement, control and laboratory use, and has been supplied in a safe condition. The present instruction manual contains some information and warnings which have to

[6] Baseline flatness 200 to 800nm. 120nm/min, 2nm data interval, medium smoothing.

be followed by the user to ensure safe operation and retain the apparatus in a safe condition. The apparatus has INSTALLATION CATEGORY II and has been designed for indoor use.

Electromagnetic Interference

This equipment has been tested and complies with the following:

EN50082-1 Generic immunity standard including:

IEC801-2	Electrostatic discharge
IEC801-3	Radiated electromagnetic fields
IEC801-4	Electrical fast transients
IEC801-5	Electrical surges
IEC801-6	Induced RF
EN50093	Mains variation

Note: Shielded Cables - All accessories, computer and peripherals should be connected to the Evolution 500 system using shielded cables to maintain the appropriate emission compliance.

SECTION 9 - GETTING THE BEST FROM YOUR NICOLET EVOLUTION 500 INSTRUMENT

9.1 Introduction

The Nicolet Evolution 500 double beam, scanning UV-Visible spectrophotometer offers one of the best value for money systems on the market. This section has been included to assist you in maintaining this performance during the working life of the spectrophotometer.

9.2 System Overview

The Nicolet Evolution 500 is a double beam spectrophotometer built around a robust aluminium base casting. The optics are mounted above the casting in a sealed enclosure. The control electronics, comprising a processor board and a power supply board, are mounted below the casting. The design makes provision for several performance variants and a family of accessories. The instrument may be controlled by an external computer or by a built-in display and keyboard.

9.2.1 Optics

The optical system is based around an Ebert Monochromator using a 1200 line/mm Holographic Grating. Slit sub-assemblies can be fitted to give variable bandwidth or one of 2 fixed bandwidths.

The lamphouse is situated in the right-hand rear corner of the instrument. The airflow in this region is arranged to remove excess heat and ozone to ensure stable lamp output. There is provision for three lamps: Tungsten for the visible region, Deuterium for the UV region and Mercury for wavelength calibration. A motor driven mirror (M1), under software control, selects the lamp to be used. The grating is mounted on an approximate sine arm which is moved by a micrometer driven by a 1.8° stepper motor (200 steps/rev). The micrometer mounting and sliding coupling to the motor are designed to minimise the effects of temperature changes on wavelength accuracy.

Wavelength accuracy is achieved by software compensation. The calibration routine finds 9 predefined emission lines over the wavelength range using Mercury and Deuterium lamps, and uses these to characterise the instrument and so calculate the correct motor position for the required wavelength.

After leaving the monochromator the beam is directed onto a beam splitter to produce the sample and reference beams. The beam splitter sends most of the available energy down the sample beam. Just beyond the beam splitter the beams pass through a modulator. This is under software control and permits the detector to see either the sample beam, the reference beam or dark.

There is provision for a Calibration Validation Unit (CVU); this fits in the sample beam just beyond the modulator. Calibration Validation can be performed either by measuring certain frequencies in the emission spectrum of the Mercury Lamp, or by using the Tungsten Halogen Lamp and a filter disk within the CVU driven by a motor under software control.

After passing through the sample compartment the beams are recombined and directed onto the detector. Provision is made for either a photodiode or a photomultiplier detector.

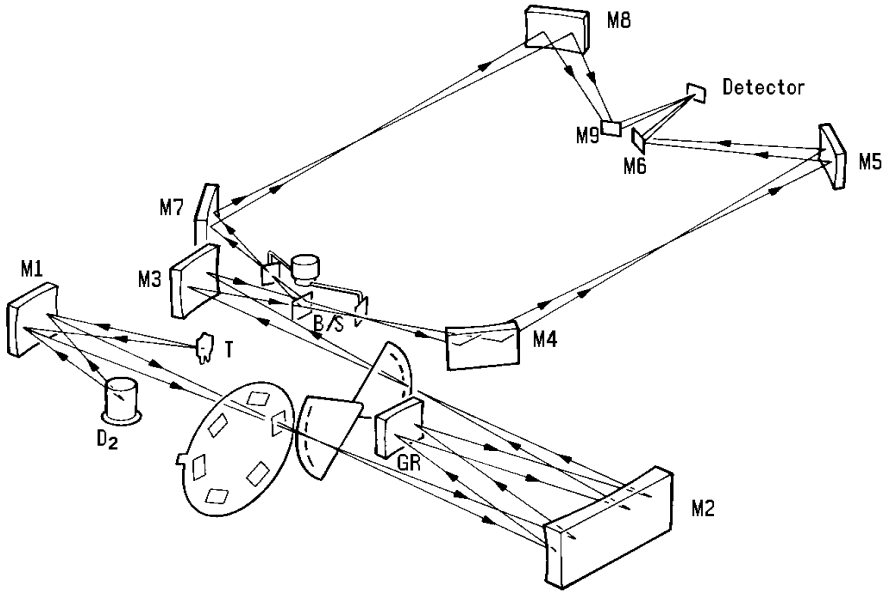


Fig 9.1 Optical diagram of an Evolution 500 spectrophotometer

9.2.2 Electronics

All of the power supplies and motor drive circuits are on a PCB mounted below the base casting. The power supplies use switching regulators running off a 24V supply derived from a mains transformer.

A sensing circuit monitors each of the supplies to ensure that they stay within acceptable limits. The Tungsten lamp supply has a soft start to prolong lamp life, and a sensing circuit to ensure the lamp filament is intact.

The instrument is controlled by a Motorola 68340 microprocessor. This provides an RS232 interface to the outside world, and in Local Control variants runs the user interface on the LCD display and Keyboard.

The main memory is made up of 512K words of flash EPROMS. These can be erased and re-programmed in circuit. This means that software upgrades can be easily performed either from the instrument disk drive or from a PC via the RS232 interface.

The start up and code for programming the flash memory is in a 64K word boot sector of the flash EPROMS. The system RAM is in two parts, 256K words of volatile RAM and 128K Bytes of battery backed RAM. Calibration parameters and serial number are stored in a 64 word EEPROM.

The 68340 has two DMA channels; one of these is used for the floppy disc interface and the other is used to transfer commands to the wavelength drive and modulator drive circuits.

Three 68230 peripheral chips provide the input/output lines used to control the optical system and interface to the accessories.

9.3 Lamps

The Evolution 500 uses two sources to cover the wavelength range specified. A Tungsten-halogen lamp provides the visible radiation and a Deuterium Arc lamp provides the UV radiation. In addition a Mercury lamp can be fitted for checking wavelength accuracy or recalibrating the instrument.

Your instrument uses a 12V 35W two-pin plug-in Tungsten lamp, which has an average life of approximately 1000 hours.

The UV radiation source is a Deuterium Arc lamp with an inline connector, prealigned for your instrument. It has a low current heater which, once the lamp has been struck, remains on to maintain maximum low drift stability and maximise lamp life. The average life is approximately 500 hours.

The Mercury lamp is an optional accessory. A Mercury lamp power supply is fitted to the instrument as standard.

9.3.1 Looking after the Lamps

Never touch the glass envelope of any lamp. This is because fingerprints will be burnt onto the glass and cannot be removed. A shorter life and lower output will result.

Use the Initialise with ON/OFF facility. The recommended life of a Deuterium lamp is 500 hours and this can be reduced by constant switching, therefore it is important that you set the Initialise with ON/OFF sequence to suit your requirements. This is set on the Local Control software from the SETUP INITIALISE page or from the Commands Set Times menu of the Vision software.

Keep track of the lamp status and replace before it fails. The Local Control software will inform you of the current lamp status (i.e. on or off) and the lamp hours used to date via the LAMPS page. Do not forget to use the RESET HOURS facility on this page when a lamp has been replaced. The VISION software shows the status of the lamps, colouring the Status Window icons blue for UV and yellow for Visible. A red background will indicate a lamp failure, accompanied by an error message. Double clicking on either lamp icon brings up a pop-up box, indicating lamp hours. It is also possible to measure the lamp energies as a percentage of the energy measured when the lamp hours were last reset. The status box also flags the recommended lamp replacement time by colouring the hours background red when the recommended number of hours has been exceeded.

Allow the lamps to warm-up. Although the instrument can be used after approximately three minutes, better stability will be achieved after 10 minutes for the Tungsten lamp and 30 minutes for the Deuterium lamp.

Always run a lifetime initialisation after replacing a Tungsten or Deuterium lamp. This resets the position over which the moving mirror searches for peak energy throughput

which will vary from lamp to lamp. This is done in Local Control software by selecting the OPTICS option on the SETUP INITIALISE page or from the Commands Initialise Lifetime menu of the Vision software.

9.4 Detectors

The Nicolet Evolution 500 spectrophotometer has a photomultiplier detector.

9.4.1 Photomultiplier Detectors

Photons of light strike the coated surface of the photocathode, which emits a number of electrons for each photon. These electrons are directed by an electric field to a dynode, which emits a number of secondary electrons for each electron which strikes it. The process is repeated through a total of nine dynodes, with the number of electrons emitted increasing each time. Finally the electrons hit the anode, where the resulting current leaves the photomultiplier and is amplified in the pre-amplifier.

The sensitivity of the photomultiplier can be varied by adjusting the voltage (EHT) between each pair of dynodes. A full description of EHT is given in Section 9.5.2.

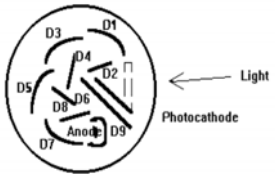


Fig 9.3 A photomultiplier detector

9.4.2 Precautions when using a Photomultiplier

The photomultiplier detectors used in the Evolution 500 are extremely sensitive devices, capable of measuring very low light levels, at lower noise than could be achieved with a photodiode detector.

At 'normal' light levels, there is not much noise difference between the two types of detector. The two situations where the PMT detector gives a significant improvement are

(a) highly absorbing samples - micro-cells, turbid samples, etc., and

(b) narrow bandwidths.

However, all photomultipliers have 'memory effects', and their performance can be temporarily harmed by extreme conditions. Evolution 500 instruments protect the photomultiplier as much as possible, by switching off the EHT supply whenever the sample compartment lid is opened. But exposure to high light levels, even with no EHT, can degrade performance. Avoid shining bright lights (sunlight, or laboratory lighting) directly into the sample compartment. Do not leave the instrument with its sample compartment lid open. If a photomultiplier is replaced, keep the new photomultiplier in the

dark as much as possible, and install it in dim light. It can take 24 hours to recover from direct exposure to fluorescent lighting.

Prolonged use at very high EHT levels can also cause noise degradation, which may take days to recover. If you use your Evolution 500 continuously at 0.2nm bandwidth, or continuously with highly absorbing sample and reference accessories, then its noise performance under high energy conditions will be worse for some time afterwards. A photomultiplier detector is capable of very high sensitivity or very low noise - but not both at the same time!

9.5 Key Concepts

9.5.1 Baselines and Zero

9.5.1.1 Default Baseline

On any double beam system, there will always be a process of 'balancing' the two beams striking the detector. Clearly, this process will be affected by any major difference between the sample or reference beams; by definition this is how a measurement is made. Therefore, a reference level, i.e. the energy reaching the detector with both beams clear, must be established for the wavelength range of the instrument. This is known as the Default Baseline, and even with both beams clear, this value will be changed very slightly by slow long term effects, e.g. changing optical characteristics.

Historically this Default Baseline was stored deep within the electronics of the spectrophotometer, and if any offset did occur in the baseline because of these long term effects, then these were remedied by a call to the local Service Engineer.

One of the major design criteria of the Nicolet Evolution 500 instruments was to make User Servicing available where possible, so access to the Default Baseline is one of these many Servicing tools.

The Default Baseline is run as follows in the factory on clear beams:

Evolution 500 Series - 190 to 900nm, 1.5nm bandwidth, 0.1 nm data interval

It is non-volatile, and is stored within the instrument on power down.

As can be seen from the above, the entire wavelength range is scanned at the smallest data interval with a 0.5 sec integration time per point, therefore the process will take at least 1 hour.

The Default baseline is run from the SETUP INITIALISE page of the Local Control Software or the Commands Default baseline of the Vision Software.

9.5.1.2 User Baseline

As the name suggests, this is a baseline set-up which can be established for any given set of parameters, scan range, bandwidth etc., to compensate for the application 'environment' currently in use over the wavelength range required, and is performed under exactly the same condition as the current scan method.

This is volatile, and is lost when power is removed from the instrument.

9.5.1.3 Zero

This is the 'beam balance' at a FIXED wavelength, and is again used to remove any offset for a given set of parameters, wavelength, bandwidth etc, to compensate for the application 'environment' currently in use.

Up to 20 discrete values are held in memory by the instrument, and are non-volatile. The last 20 wavelengths measured are always held.

9.5.1.4 How baselines are used

DEFAULT BASELINE

This is factory set, and specifically should only be rerun if:

1. The wavelength is recalibrated.
2. The optics are cleaned, or changed.
3. After EHT CALIBRATION (see Section 9.5.2).

THIS PROCESS WILL TAKE APPROX. 60 MINUTES.

WITH THE DEFAULT BASELINE CORRECTLY SET, THE INSTRUMENT BECOMES A 'CLASSICAL DOUBLE BEAM', i.e. BOTH BEAMS BALANCED, AND ANY DIFFERENCE RECORDED AS A MEASUREMENT. NO ADDITIONAL BASE LINES ARE REQUIRED FOR ROUTINE MEASUREMENT; USER BASELINES (SEE BELOW), HOWEVER, SHOULD BE USED FOR ABSOLUTE ACCURACY.

USER BASELINE

With Single beam instruments, a baseline is performed (usually immediately) before measuring the sample. Whilst this could be conceived to be a disadvantage, slowing down the sample measurement process, in the Evolution 500 this procedure is fast; with the added benefit that the user baseline effectively compensates for any minor changes in the background environment occurring after performing the Default Baseline. The user therefore gets a combination of the best of both instrument types, i.e. double beam operation with accurate baseline correction.

ZERO

When this is used by any of the controlling software packages, the wavelength value used is stored in volatile memory and the instrument is zeroed. Returning to any stored wavelength/bandwidth combination will re-establish the stored zero value.

9.5.1.5 How to get the best results?

These are achieved if a User baseline (or zero) is run immediately before the first sample, as the instrument will always use a User baseline in preference to the Default.

9.5.2 EHT

Explanation - what is a profile?

The light energy received by the detector varies very considerably. Many components e.g. lamps, mirrors, gratings, etc. have efficiencies which vary with the wavelength used. Therefore, for a fixed bandwidth, the energy at the detector varies by about 100:1 over the range from 190 to 900nm. In addition, varying the bandwidth has a large effect on the energy, which is proportional to the square of the bandwidth. The change of energy from 4nm bandwidth to 0.2nm bandwidth is 400:1 Thus the total energy variation is 40,000:1

For a photomultiplier Tube (PMT) to operate it must have a voltage applied to it. This is typically a few hundred volts up to 1200 V. This voltage sets the gain of the PMT.

To get the best performance from the signal processing electronics, the detector signals need to be kept as large as possible. Evolution 500 instruments optimise the signal level by varying the high voltage (EHT) supply to the photomultiplier. Electrons emitted by photons striking the photo-cathode are multiplied by nine stages of gain at the intermediate dynodes before reaching the anode. The overall gain is approximately proportional to the seventh power of the voltage. Thus doubling the photomultiplier supply voltage will increase the gain by $2^7 = 128$. Tripling the voltage will increase the gain by $3^7 = 2187$. Four times the voltage increases the gain by $4^7 = 16{,}384$, etc.

EHT profiles

The Evolution 500 has two EHT tables which are used to compensate for variations in energy by changing the voltage applied to the PMT during routine operation. One is set up for normal operation (NORMAL) and the other (HIGH ABSORBANCE) is used when an accessory which absorbs a significant amount of light is present.

There is also a series of Flat tables which simply apply a constant voltage to the PMT for use when scanning for emission peaks. On variable bandwidth instruments, because the amount of light changes with bandwidth, the EHT has to be scaled appropriately. This is performed when automatic changeover is selected and when the mercury lamp is being scanned. In all other situations the scaling is not used to ensure that e.g. deuterium lines can be scanned satisfactorily.

In addition to the possibilities for changing the EHT table the Evolution 500 also allows for a number of possibilities when selecting lamps. In normal operation the instrument switches automatically between the tungsten and deuterium lamps at the requested lamp change wavelength. This switching can be over-ridden so that only one lamp is used over the whole range. On the Evolution 500 it is possible to select the tungsten, deuterium and mercury lamps in this way.

The interaction between the lamp switching and the EHT tables is shown in the table below:

	Normal	High Absorbance	Flat
Auto (315-340 nm)	Constant signal at all wavelengths[1]	Constant signal at all wavelengths (with accessory present)[1]	Minimum of Tungsten part of Normal table
Tungsten	Constant signal from lamp change to 900nm, constant EHT from 190 nm to the lamp change (values taken from Normal table)	Constant signal from lamp change to 900nm, constant EHT from 190 nm to the lamp change (values taken from HAA table)	Minimum of Tungsten part of Normal table
Deuterium	Constant signal from 190 nm to lamp change, constant EHT above lamp change (values taken from Normal table)	Constant signal from 190 nm to lamp change, constant EHT above lamp change (values taken from HAA table)	Minimum of Deuterium part of Normal table
Mercury	Flat[2]	Flat[2]	Set during peaking up of lamp[2]

Notes: 1) The EHT is scaled depending on the bandwidth.
2) The EHT is scaled depending on the bandwidth to achieve comparable peak heights at all bandwidths

To summarise, there are three different EHT profiles:

Normal. This profile adjusts the SAMPLE signal level to the optimum value throughout the wavelength range.

High Absorbance. This profile assumes that there is always considerable optical attenuation (1A or more) in the SAMPLE beam. It therefore increases the EHT until the REFERENCE signal is at the optimum value throughout the wavelength range. This is useful with highly absorbing accessories where an EHT can be calibrated specifically for the accessory and used only when it is fitted.

Flat. This profile maintains a constant EHT value throughout the wavelength range. It is used only when the instrument is operated in EMISSION mode, to measure the emission lines of the Deuterium or Mercury lamp (eg for checking wavelength calibration). When making these measurements the Mode should normally be set to **INTENSITY** on the SCAN PARAMETERS page.

Calibration - how and why?

How, using Local Control Software

Press HOME
Press SETUP
Select EHT (ENTER)
Use the up/down arrow keys to highlight the appropriate table (NORMAL or HIGH ABS) and ENTER to select.
Press CALIBRATE
Select PROCEED (ENTER)

It is NOT recommended to try calibrating the FLAT EHT profile.

How, using VISION software

From the **SCAN** or **FIXED** menu bar, key
COMMAND
EHT CALIBRATION
NORMAL or HIGH ABS

Why?

The appropriate EHT profile (Normal or High Abs) should be calibrated if there has been any significant change in the energy as seen by the photomultiplier. Possible causes are:

Lamp energy decayed since new to below 75%. (CHECK. In Local Control Software click on the Lamps Function Key on the HOME Page, then on the Energy Function Key on the LAMPS page. In VISION click on the lamp symbol in the VISION status box, then click on "Measure Energy").
New lamp fitted.
Highly absorbing accessory fitted (use High Abs profile).
Instrument used in very cold or very hot laboratory.
Lamp selection mirror cleaned.
Filters or grating changed.

9.5.3 Optical Initialisation

Every time the instrument is switched on, the following sequence occurs:

Electronics:
All power supplies are tested.
All memory is tested.
The detector pre-amplifier offset voltage is adjusted.

Filters and Slits:
The movement of the filter wheel is tested, and it is placed at the correct filter. The self test (if fitted) is driven to the clear beam position.
The variable slit plate (if fitted) is driven to the widest slits.

Tungsten lamp:
The lamp is switched on, and its current checked.
The monochromator is driven to its zero order sensor.
The monochromator is then driven to approximately 500 nm.
The lamp select mirror is scanned to find the exact position of the tungsten lamp.

Monochromator:
Using the tungsten lamp, the monochromator is scanned to find the exact position of zero order light.

Slits:
Readings are taken using each slit in turn (i.e. at each bandwidth) and the EHT photomultiplier supply optimised to give the factor for each slit. These factors are checked for correctness.

Self test:
If a Self-Test accessory or CVU accessory is fitted, the built-in filters are used to check for approximate absorbance accuracy at 0A, 1A ,2A and 3A.

Deuterium lamp:
If selected to initialise with Deuterium, the lamp heaters are applied. When warm, the lamp is struck.
After a stabilising delay, the heaters are turned off.
The lamp current is checked.
The monochromator is driven to 250nm.
The lamp select mirror is scanned to find the exact position of the Deuterium lamp.

9.5.3.1 Life-time Initialisation

This goes through the same sequence of steps as the normal optical initialisation, but searches through a wider range when it is finding the positions of the lamps and monochromator. This life-time initialisation, which takes longer to run, is necessary after lamps have been changed, any optical components have been changed, or if the processor pcb (which holds the non-volatile memory containing the positions) has been changed.

9.5.4 Scan Speed

When scanning a sample the aim should be to scan the selected range as quickly as possible without any loss of accuracy for either wavelength or absorbance. The optimum scan speed for any sample depends on the interaction of a number of complex factors. For example, the number and sharpness of peaks, the wavelength range of the scan, the maximum absorbance of the sample, the required noise performance, the data resolution or interval between readings and the type of detector, to name but a few.

The stepping monochromator design and advanced signal processing of the Evolution 500 instruments mean that wavelength accuracy is independent of scan speed, therefore the main consideration in selecting scan speed will be the acceptable noise level on the spectrum. The following list gives the background information relevant to noise and scan speed.

(1) The amount of energy, or signal, reaching the detector at any wavelength depends on the source energy and the sample absorption at that wavelength.

(2) Noise is proportional to the square root of the signal, therefore the amount of noise increases as a proportion of the signal as the level of signal falls; consequently the amount of noise varies across the scan.

(3) Where high absorbance coincides with low source energy the noise due to the signal is markedly greater than where high absorbance coincides with high source energy.

(4) Noise can be reduced by increasing the time for which a data point is measured (integration time).

(5) Noise can be made constant across the scan by varying the integration time at each data point.

9.5.4.1 Standard

The Standard scan speed option allows the setting of fixed scan speeds. The maximum rate at which the spectrophotometer can scan is 1200 data points per minute. This equates to 2400 nm/min at 2nm data interval (or 120nm/min at 0.1nm data interval) with an integration time of 15 milliseconds. By slowing the scan speed and/or increasing the data interval the integration time can be increased and consequently noise decreased.

9.5.4.2 Intelliscan

Intelliscan is a means of optimising the noise on a spectrum by varying the integration time at each data point and therefore the scan speed over the spectrum.

How Intelliscan Works

As the energy hits the detector, an analogue signal is produced which is converted to a digital signal by the analogue to digital converter (ADC). For the ADC to work effectively, the signal reaching it has to be within a preset range. If the signal is outside this range then it is amplified. The level of amplification is called the gain. So if a given signal is below the range specified for the ADC, another detector reading is taken and the gain increased. This process continues with the gain increasing until the signal level is within the acceptable range. A measurement is then taken and the spectrophotometer moves on to the next wavelength. The level of gain has no effect on the strength of the signal; it simply multiplies up a weak signal to fit the appropriate ADC range.

The level of gain is, however, a direct indicator of the amount of energy hitting the detector which in turn is dependent on the combination of source energy less absorbance of the sample. Therefore the level of gain set at any wavelength can be used to set the integration time required at that wavelength. High energy at the detector requires no gain and therefore a short integration time; low energy requires high gain and therefore a longer integration time.

This is what Intelliscan does by intelligently varying the integration time at each data point of the scan depending on the amount of light hitting the detector as measured by the gain required to fill the ADC.

When Should Intelliscan be Used?

Intelliscan can be used in any application to improve the quality of the result. However, where the most benefit is seen is where high definition is required from a sample which has strongly absorbing peaks in both the UV and Visible regions.

9.6 Wavelength Accuracy and Recalibration

Wavelength accuracy is the most important performance criteria of a spectrophotometer. In the Evolution 500 a combination of stepping monochromator and software compensation equation based on 9 Mercury and Deuterium emission lines should give years of trouble-free service. However there are circumstances where it may be necessary to recalibrate your instrument.

Factors Affecting Wavelength Accuracy

Physical Shock
Accuracy may be affected if the spectrophotometer is jolted violently, dropped, or subjected to severe or prolonged vibration.

Temperature
Problems may be found if the operating temperature is significantly different from the temperature at which the spectrophotometer was last calibrated.

Replacement of key optical components
The instrument will need recalibrating if any of the key optical components are replaced.

Mechanical wear
The instrument has been designed to minimise the effect of wear and this should not be a problem.

If for any reason the wavelength accuracy is suspect or if a CVU or Self Test has failed on wavelength accuracy, first check that the instrument is operating at or about the correct temperature. All instruments are calibrated at room temperature and wavelength differences of between 0.1 and 0.3nm per 10°C are not uncommon.

There are two recalibration options available using either the Deuterium lamp alone or both the Deuterium lamp and optional Mercury lamp.

The Deuterium lamp recalibration uses the Deuterium emission line at 656.1nm to adjust the software compensation equation and is intended to remove the effects of small movements of optical components and shifts due to temperature, shock or vibration. If the errors found are linear and no more than 0.5nm then a Deuterium calibration can be used. The process will take about five minutes and is fully described in the appropriate software manual. This option only applies where an existing calibration is present.

The Mercury lamp calibration remeasures all 9 relevant emission lines from the Mercury and Deuterium lamps then recalculates and replaces the software compensation equation. The process requires the Mercury Lamp accessory (part no 9423 UV9 0023E) and will take at least 15 minutes. This option applies where there are significant wavelength errors or where the original calibration has been lost. If a Mercury lamp calibration is required other than because of the replacement of a major optical

component then it is likely that there is a serious problem with the spectrophotometer that requires investigation by a trained engineer.

9.7 Absorbance Accuracy

If for any reason the absorbance accuracy is suspect, first check the instrument using a set of traceable certified calibrated absorbance standards (see Section 9.11). If incorrect results are still returned a calibration of the detector gains is possibly required; this procedure can be carried out by a user via a PC in terminal mode. For further information contact your local customer support office.

9.8 Cleaning the Optics

Evolution 500 instruments have tri-sealed and coated optics which means that very little maintenance is required and mirrors should not require cleaning. However, dependent on the local environment and the usage rate of the Deuterium lamp, the reflectivity of M1, the lamp mirror, will degrade with time; this effect can be seen by eye as a "milky" coating on the mirror surface. No other mirror should be cleaned.

Cleaning the M1 mirror requires that the Deuterium lamp is switched on to adjust the mirror when clean. For this reason, only those persons who have been on an approved Thermo Electron training course, and who are fully familiar with the precautions necessary, should undertake this procedure.

9.9 Standby and Wakeup

When using any spectrophotometer the most accurate results will be obtained only when the temperature of the instrument is in equilibrium with its surroundings. The recommended "warm-up time" required to reach this equilibrium is approximately 30 minutes.

In a busy laboratory this may be regarded as an unacceptable waste of time, so to overcome this inconvenience the VISION software offers the two facilities of Standby and Wakeup, which can be used in conjunction with the Nicolet Evolution 500. These enable the instrument to be 'warmed-up' and ready for use at the start of every day.

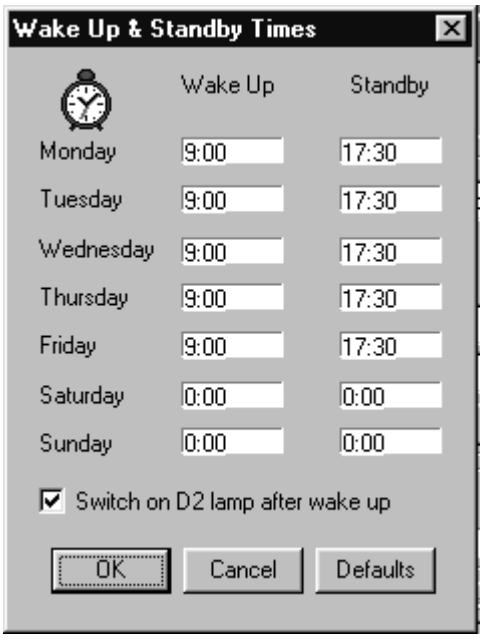


Fig 9.4 Vision Wake Up and Standby Window

As you can see from Fig. 9.4, it is possible set the daily times at which the instrument will automatically start up, and initialise before the start of the working day, and also 'go back to sleep' in the Standby mode at the end of the day.

Should you wish to begin working immediately in the UV area of the spectrum, there is the added facility of being able to initialise the system with the Deuterium lamp turned on.

If the spectrophotometer is in use when the Standby time is reached, don't worry; the software is intelligent and will not allow the instrument to go to STANDBY until at least 5 minutes have elapsed without any further actions occurring in the software. When the instrument has entered Standby mode the red LED on the front of the instrument is illuminated.

9.10 Validation of Data

If you have reached this section by reading and implementing all the previous chapters, you can now be confident that your Evolution 500 spectrophotometer is at the very least performing to specification; but how do you prove it?

Thermo Electron have produced a variety of aids to assist the user in the process of validation and calibration, and these are briefly detailed below.

9.10.1 Accessories

VALIDATOR PACKAGE

Validator 5 Log Book 10 03 0101

Designed to assist with the Qualification requirements of the Regulated Environment, this package provides (in the form of a log book and guide) all the documentation necessary to perform this task.

Note: The content of these two packages is identical; the A or E suffix simply defines the ring file format used i.e. 3 ring - American or 4 ring - European.

SELF TEST UNIT

9423 UV6 1200E SELF TEST UNIT

This unit will provide measurements of Wavelength, Absorbance, Stray Light, Noise and Drift, compared to a nominal expected value. If the unit is supplied fitted to the spectrophotometer these values are the values recorded from the spectrophotometer when first fitted in the factory. If you require traceable, certified values see the Calibration Validation Unit (CVU) detailed below.

9.10.2 Literature

To complement the Evolution 500 instrument, a set of Application Notes has been produced, which covers the fundamental principles of instrument calibration.

AN-01142 Wavelength Accuracy - Its Measurement and Effect on Performance in UV-Visible Spectrophotometry

AN-01143 Absorbance Accuracy - Its Measurement and Effect on Performance in UV-Visible Spectrophotometry

AN-01144 Stray Light - Its Measurement and Effect on Performance in UV-Visible Spectrophotometry

AN-01145 Changing scan speed, and the associated effects on spectra in UV-VisibleSpectrophotometry

AN-01146 Instrument Resolution - Its Measurement and Effect on Performance in UV-VisibleSpectrophotometry

Contact your local Thermo Electron Customer Support organisation if you wish to obtain these notes.

9.11 Third Party Validation

All Quality or Accreditation schemes require irrefutable proof of instrument calibration, and this is achieved by reference to a third party. This can be achieved either by receipt of a Certificate of calibration from this independent source, or by the use of calibration standards, traceable to a recognised National authority, e.g. The National Physical Laboratory or NIST.

Thermo Electron have produced a variety of aids to assist the user in the process of validation, and these are briefly detailed below. Further information can be obtained from your local Thermo Electron customer support organisation.

9.11.1 Accessories

9423 UV9 0023E	MERCURY LAMP

The emission lines produced from a discharge lamp are characteristic of the source element. The wavelengths are invariable and are therefore fundamental physical standards.

A low-pressure mercury lamp has a number of intense lines that cover a large part of the UV and visible range, i.e. 250 - 580nm.

Therefore, whilst this lamp can be used for calibration and checking, its reliance on fundamental physical parameters also makes it acceptable as a validation tool.

CALIBRATION VALIDATION UNIT

9423 UV6 1250E	CVU (NPL)
9423 UV6 1260E	CVU (NIST)

This unit will provide measurements of Wavelength, Absorbance, Stray Light, Noise and Drift, calibrated traceable to The National Physical Laboratory or NIST. Supplied with a certificate of calibration, this unit requires re-calibration at yearly intervals to ensure compliance.

WAVELENGTH & ABSORBANCE STANDARDS

9423 179 38901	SET OF 9 ABSORBANCE STANDARDS
9423 185 03001	SET OF 4 ABSORBANCE STANDARDS
9423 185 03111	SET OF 2 WAVELENGTH STANDARDS

These standards are provided as calibrated sets, traceable to the NPL and NIST. For more information on these, and the other validation accessories, see below.

9.11.2 Literature

The following application notes have been produced to assist users who wish to learn more about certified traceable referencs materials.

AN-01147 Thermo Electron Corporation Standards for UV-Visible Spectrophotometry

AN-01150 Metrological Traceability Questions and Answers

Contact your local Thermo Electron Customer Support organisation if you wish to obtain these notes.

9.12 Instrument Parameters

Certain basic parameters are stored in the spectrophotometer's memory which are essential to the initialisation sequence of the instrument. Examples are the full identity of the instrument, gain settings for absorbance accuracy and the coefficients of the wavelength calibration software compensation equation. These particular parameters are archived in the factory and are recorded on a label attached to the inside of the bottom cover. This information will be used by the service engineer to reprogram the flash EEPROM when some parts are replaced, and also in the unlikely event of EEPROM corruption. The label contents should always be updated by a person who has attended an Evolution 500 service course or a Thermo Electron service engineer when the gains or wavelength have been recalibrated.

A typical parameter label contains:

Serial No: 012345
Gains: 1.0000 2.7499 7.3069 19.9791 53.5281 146.3273 391.934 1042.2919
W/L Cal: 1.001403E+00 -6.402363E-07 3.312368E-11 0.0E+00
VAR: PD UV2-200 012345 190 900 512 nol 2.0 NOWAV NOCOR

9.13 User Access

Your instrument was designed for ease of maintenance and as such a number of the modules present in the instrument can be replaced by the user. Some of the operations do, however, require specialist knowledge or formal safety training - therefore three categories of component exist. These are described below.

Category A - Consumables

These items are replaceable by any non-technical user who has read Section 3 - Safety of the UV Series Installation and Maintenance Manual.

Tungsten Lamp
Deuterium Lamp
All Accessories
Mains fuse

Category B - Non-critical components

These are items which require no special alignment jigs or tools.

They can be replaced by a technically qualified person who has attended an approved Thermo Electron training course.

Disc drive
Lamp mirror (M1) replacement and cleaning
Printed circuit boards
Lamp mirror drive assembly
Grating holder assembly
Filter assembly
LCD Assembly
Wavelength drive assembly
Modulator assembly

Category C - Critical components

These are items or modules that require specialised alignment tools and are only replaceable by a Thermo Electron service engineer or appointed agent.

Collimator mirror
Post sample compartment optical system
Detector assembly
Transformer assembly

9.14 Evolution 500 - Recommended Service Intervals

EVERY 500 HOURS (OR SIX MONTHS)

Change the Deuterium Lamp
Re-calibrate the EHT.
Rerun the Default Baseline.
Check the Lamp Change mirror for contamination and clean if necessary.
Clean all sample compartment and external surfaces.

Perform the following checks if these are not already being done on a regular basis:
Wavelength Accuracy (re-calibrate if required)
Absorbance Accuracy
Baseline Flatness
Noise
Stray Light

EVERY 1000 HOURS (OR 12 MONTHS)

Check calibration expiry dates on CVU units, filters, etc. - Return for re-calibration if necessary.
Change the Tungsten Lamp.
Change the Deuterium Lamp.
Re-calibrate the EHT.
Rerun the Default Baseline.
Check the Lamp Change mirror for contamination and clean if necessary.
Clean all sample compartment and external surfaces.
Lubricate the micrometer drive with Mobil Vactra No. 2 oil (Section 5.5.1 UV Series Service Manual).

Perform the following checks if these are not already being done on a regular basis:
Wavelength Accuracy (re-calibrate if required)
Absorbance Accuracy
Baseline Flatness
Noise
Stray Light

EVERY 2000 HOURS (OR 24 MONTHS)

Check mains & connection leads for damage, solvent attack, etc.
Check calibration expiry dates on CVU units, filters, etc. - Return for re-calibration if necessary.
Change the Tungsten Lamp.
Change the Deuterium Lamp.
Re-calibrate the EHT.
Rerun the Default Baseline.
Check the Lamp Change mirror for contamination and clean if necessary.
Clean all sample compartment & external surfaces.
Lubricate the micrometer drive with Mobil Vactra No. 2 oil (Section 5.5.1 UV Series Service Manual).

Perform the following checks if these are not already being done on a regular basis:
Wavelength Accuracy (re-calibrate if required)
Absorbance Accuracy
Baseline Flatness
Noise
Stray Light

SECTION 10 - MAINTENANCE

The information given in this section deals only with those parts of maintenance or service which can be safely carried out by the user. Work other than that detailed should be carried out by a service engineer.

10.1 Routine Maintenance

Very little maintenance is required to keep the spectrophotometer in good working condition. The interior should be kept as dust free as possible and the sample compartment cleaned regularly; wipe off spilt chemicals immediately. The sample compartment has a drain facility to prevent excessive spillage causing damage to the electronics; a drain tube can be attached for collection by an appropriate vessel.

10.2 Cleaning Instrument Exterior

The exterior of the instrument can be cleaned periodically as follows:

CAUTION: Do not allow moisture to leak into the instrument.

(1) Switch off the Spectrophotometer and disconnect from the mains supply.

(2) Using a lint free cloth dampened with a weak solution of detergent and water, wipe the exterior surface of the instrument as necessary.

(3) Wipe over with a cloth dampened with plain water.

(4) Dry the surface with another cloth.

10.3 Removal and Replacement of Tungsten Halogen Lamp

WARNING: Switch off and disconnect the spectrophotometer from the mains and allow the lamp to cool for at least 15 minutes before proceeding.

(1) Remove the top rear cover by turning each fastener one quarter turn anti-clockwise and sliding the cover back and up to remove. See Fig 10.1.

(2) Lift out black metal light shield.

(3) Hold the Tungsten lamp and pull upwards to remove, see Fig 10.2.

Note: There are variations in the filament height of tungsten lamps from different manufacturers. In order to cope with this some lamps supplied may have spacers included. These spacers should be fitted under the tungsten lamp holder, i.e. between the holder and the main base casting.

If, subsequently, a lamp is supplied without a spacer, ensure that any spacer already fitted under the holder is removed.

CAUTION: When fitting the new tungsten halogen lamp, avoid handling the silica envelope. Finger marks become burnt on and cannot be removed after the lamp is switched on. This will affect the output characteristics of the lamp. Contamination is best avoided by keeping the lamp within its protective sleeve or polythene bag, with the pins protruding, until the lamp has been installed in its holder. Alternatively a paper shield may be wrapped around the lamp envelope. If the silica envelope does become contaminated, clean with a degreasing solvent such as acetone (propanone) before the lamp is switched on.

(4) Use the new lamp's protective sleeve, polythene bag or a piece of tissue paper wrapped around the lamp and insert the pins into the socket. When the lamp is in place remove the protective sleeve, polythene bag or paper shield.

(5) Replace black metal light shield.

(6) Replace the top cover.

(7) Reconnect the spectrophotometer to the mains supply and switch on.

(8) Allow half an hour for warm up time.

(9) Lamp hours must be reset from the controlling software. See the Local Control Software Operating Manual or refer to the Vision Help Text.

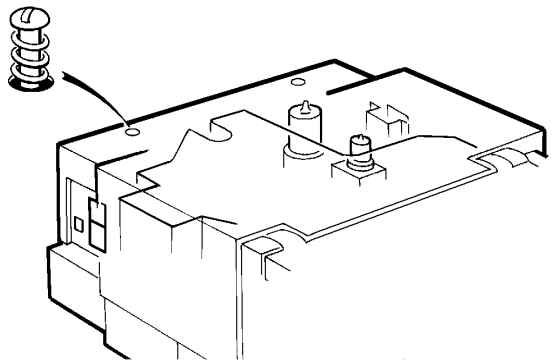


Fig 10.1 Rear Cover removal

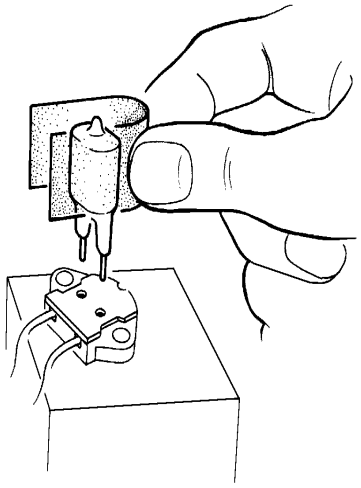


Fig 10.2 Tungsten Lamp replacement

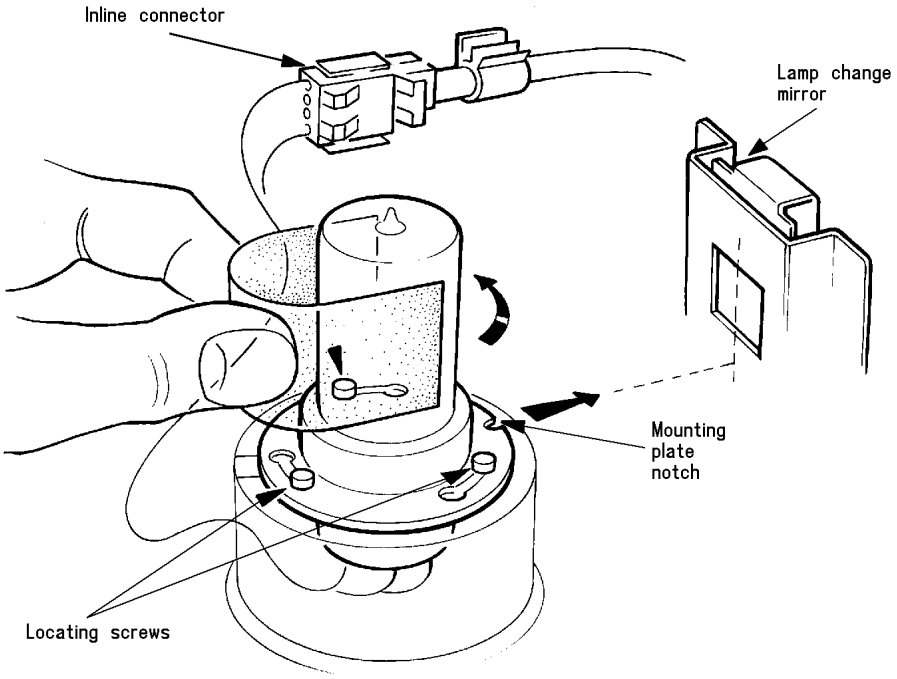


Fig 10.3 Deuterium Lamp replacement

10.4 Removal and Replacement of Deuterium Lamp

WARNINGS: (1) Switch off and disconnect the spectrophotometer from the mains supply and allow the lamp to cool for at least 15 minutes before proceeding.

(2) UV radiation from a Deuterium lamp can be harmful to the skin and eyes. Always view the lamp through protective glasses that will absorb UV radiation. Avoid looking directly at the Deuterium arc. Do not expose the skin to direct or reflected UV radiation.

(1) Set the power switch to off and disconnect the spectrophotometer from the mains supply.

(2) Remove the top rear cover by turning each fastener one quarter turn anti-clockwise and sliding the cover back and up to remove. See Fig 10.1.

(3) Make sure the lamp has cooled. Disconnect the lamp at the inline connector, see Fig 10.3. Using the key provided loosen the three locating screws, rotate lamp assembly anti-clockwise and lift lamp out.

CAUTION: When fitting the new deuterium lamp, avoid handling the silica envelope. Finger marks become burnt on and cannot be removed after the lamp is switched on. This can affect the output characteristics of the lamp. Handle only the base of the lamp or the mounting plate. If the silica envelope does become contaminated, clean with a degreasing solvent such as acetone (propanone) before the lamp is switched on.

(4) Take the new lamp, handling it by the base or mounting plate, or through a polythene bag or paper shield. Identify the notch in the mounting plate. Locate the lamp such that the notch points towards the lamp change mirror. Tighten locating screws with the key provided. Remove protective wrapping.

(6) Re-connect the new lamp at the inline connector.

(7) Refit top cover.

(8) Reconnect the spectrophotometer to the mains supply and switch on. Allow half an hour for warm up time.

(9) Lamp hours must be reset by the controlling software. See Section 9.9 of the Local Control Software Operating Manual or refer to the Vision Help Text.

10.5 Renewal of Fuses

All the following fuses are located on the Power Supply Unit and Motor drive Printed Circuit Board except for the Mains fuse. A fuse must always be replaced with one of the correct type and value as detailed.

WARNING: Switch off the spectrophotometer and disconnect from the mains before replacing a fuse.

Note: If a fuse blows continually, this indicates a fault which should be dealt with by a Thermo **Electron** engineer.

10.5.1 Mains Fuse

This fuse is located in the mains connection plug on the left-hand rear side of the instrument. Disconnect the mains cable, slide the window up and pull the lever marked FUSE PULL to remove. Only the following type of fuse should be used, see Fig 10.4.

110V operation: 7A (2422-086-01435)

240V operation: 4A (2422-086-01428)

10.5.2 Internal Fuses

Location: PSU and motor drive pcb beneath optical bench.

Access to the internal fuses.

(1) Disconnect the mains supply. Remove any loose articles from the sample compartment such as cells, etc.

Note: If the Sipper accessory is fitted ensure the cell is empty. Tip the instrument up and slowly backwards onto its rear end, which is designed for that purpose. See Fig 10.5.

(2) Remove the eight retaining screws and remove bottom plate. See Fig 10.5.

(3) Fuse locations are shown in Fig 10.6. Remove fuses by holding the top cap, pressing down and turning anti-clockwise. This releases the catch allowing the cap and fuse to be extracted.

(4) Replace the faulty fuse, then replace the bottom plate by reversing the procedures in (3) and (2).

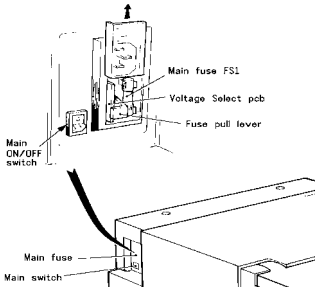


Fig 10.4 Mains Fuse replacement

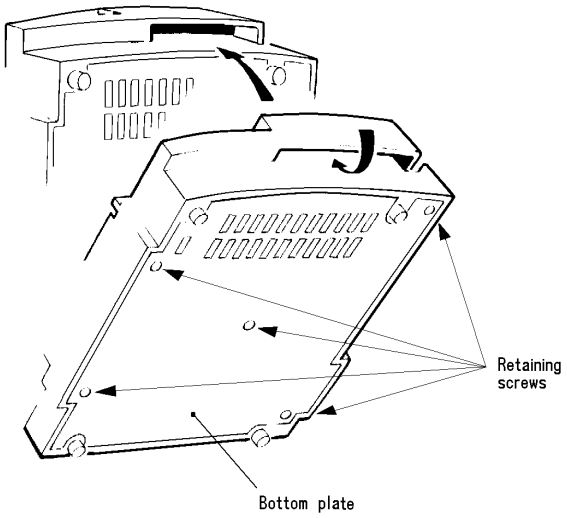


Fig 10.5 Bottom Cover removal

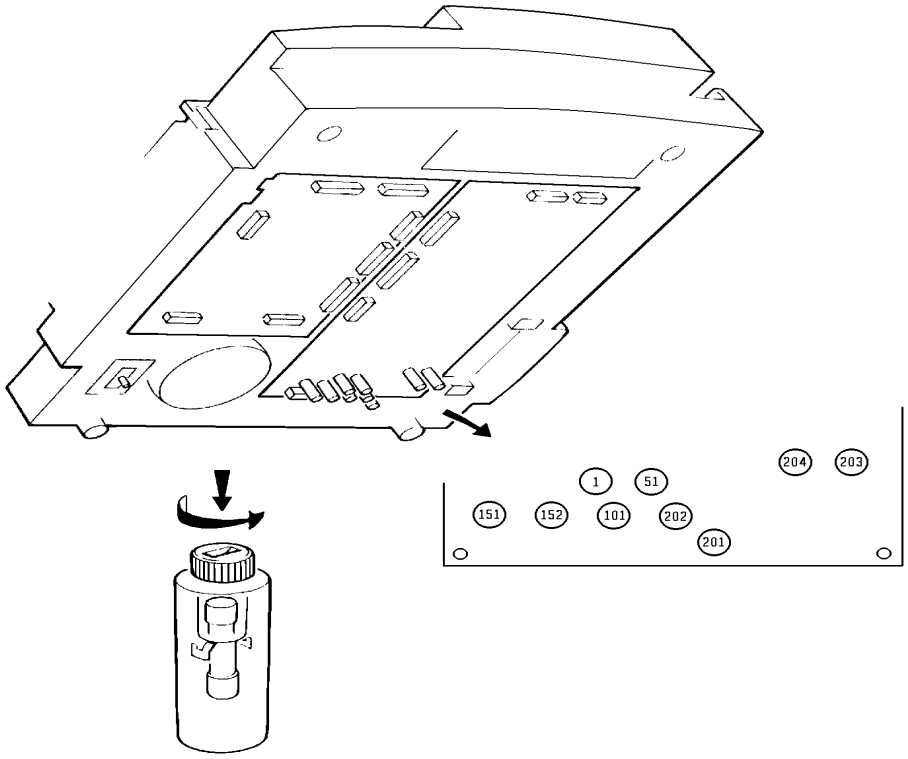


Fig 10.6 Internal fuse locations

Fuse	Value	Part Number
FS1	2.0 A	2422 086 01031
FS51	6.3 A	2422 086 01136
FS101	6.3 A	2422 086 01136
FS151	1.0 A	2422 086 01021
FS152	1.0 A	2422 086 01021
FS201	50 mA	2422 086 01002
FS202	1.0 A	2422 086 01021
FS203	1.0 A	2422 086 01021
FS204	2.0 A	2422 086 01031